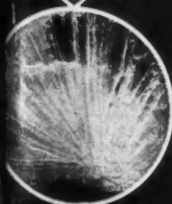
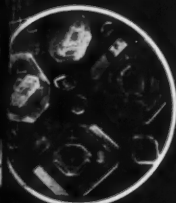


CHEMISTRY

NOV 27 1951

LIBRARY



Petrochemicals.....	1
Middle East Oils.....	7
Back Cover Picture: Substitute For Yeast.....	14
Bottled Gas For Buses.....	16
Petroleum Fuels Face the Future.....	20
Chemicals on Parade.....	24
Rare Metal Inspects Aluminum.....	25
For the Home Lab: All About Oxalic Acid.....	27
Industries Cure Stream Pollution.....	29
Progress in Peroxides.....	33
Discoveries in Chemical Fields.....	40
Mold Produces Grain Alcohol.....	43
Slippery Customers.....	45
Book Concentrates.....	47
Proudly Presented.....	48
Editorial: Whose Oil? Inside Front Cover	

50¢

Whose Oil?

► SUPPOSE you know how to process one of the world's great natural resources and are willing to spend a great deal of money to develop an outcrop of it on your neighbor's land. How far are you justified in pursuing your object — of benefitting the world by your ability to supply its needs — if your neighbor perversely refuses your kind offer to improve his property?

Does the owner of the land have the sole right to say whether such material, for which there may be insistent demand, shall be put to use or allowed to remain unused? Does the technically competent man have the right to buy such material at a bargain from his neighbor who does not know its value? To invest his own money in operating machinery for such use on his neighbor's land? To work such a deposit if his neighbor takes no interest in it, or has not the technical skill to do it?

The so-called backward nations are no longer as unsophisticated as they used to be. They may or may not have the know-how to build refineries, but they know the value of the product. They possibly have an exaggerated idea of the profits. They may underestimate the difficulty of keeping a technical plant in operation. One can understand how the technically trained man dislikes to see a smoothly running plant turned over to strangers. How far this is a question of technical competence and how far a matter of political or personal antagonism is difficult to distinguish. But one can understand, also, the feelings of people who see 97% of their resources going out of the country, for the benefit of an alien and unsettling way of life.

Ownership of natural resources is a many-faceted problem. It probably will never be settled until it is made obsolete by transmutation or photosynthesis, or some process as yet undreamed-of.

CHEMISTRY

Vol. 25, No. 3

Formerly The Chemistry Leaflet
Including The Science Leaflet

November, 1951

Published monthly, September through May, by Science Service, Inc., the non-profit institution for the popularization of science. Publication Office: 119 South Frazier St., State College, Pa. Entered as second-class matter at the Post Office, State College, Pa., under Act of Congress of March 3, 1879. Address communications to the Publication Office; or to the Editorial Office: 1719 N Street N.W., Washington 6, D. C.

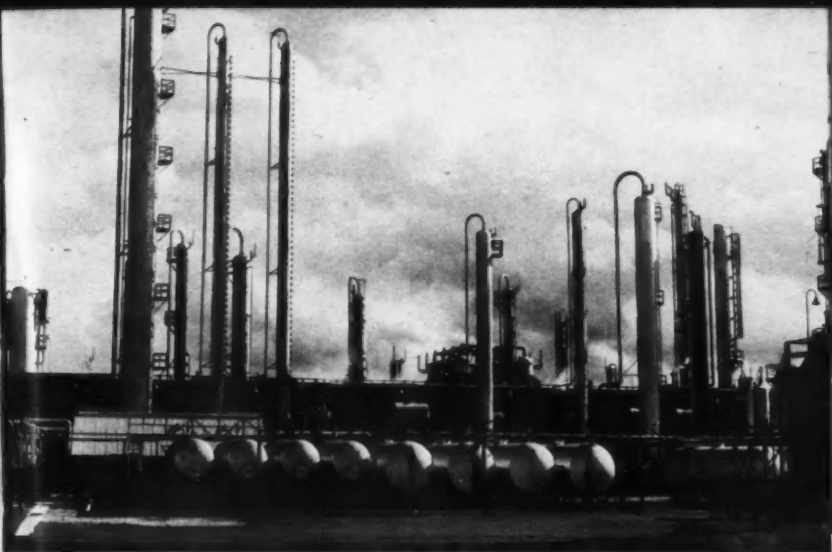
\$4 a Year; Two-Year Subscription \$7; Your Own and a Gift Subscription \$7 a Year. 50c a Copy. Ten or more subscriptions to the same address: \$2.90 a Year each. Subscriptions preferred for full volumes only, September through May inclusive; back copies sent. No charge for Foreign or Canadian Postage.

Editors: WATSON DAVIS and HELEN MILES DAVIS

Consulting Editor: PAULINE BEERY MACK (Editor 1927-1944)

Copyright 1951 by Science Service, Inc. All rights reserved. Science Service issues press service for newspapers and magazines, publishes Science News Letter (weekly), issues THINGS of Science (monthly) and administers Science Clubs of America.

Science Service is the educational and scientific institution organized in 1921 as a non-profit corporation with trustees nominated by the National Academy of Sciences, the National Research Council, the American Association for the Advancement of Science, the E. W. Scripps Estate and the Journalistic Profession.



► ORGANIC CHEMICALS find their main source in petroleum in increasing quantities. This Chemical Plant of the Celanese Corporation of America, at Bishop, Texas, produces materials which ultimately wind up as rayon textiles.

Petrochemicals

► CATALYSIS, the most mysterious tool in the chemist's arsenal of processes, holds the secret of a new source of chemicals now appearing on the market. What "coal tar" was to chemists a generation ago, petroleum, through the aid of catalytic processes, is becoming at the present time.

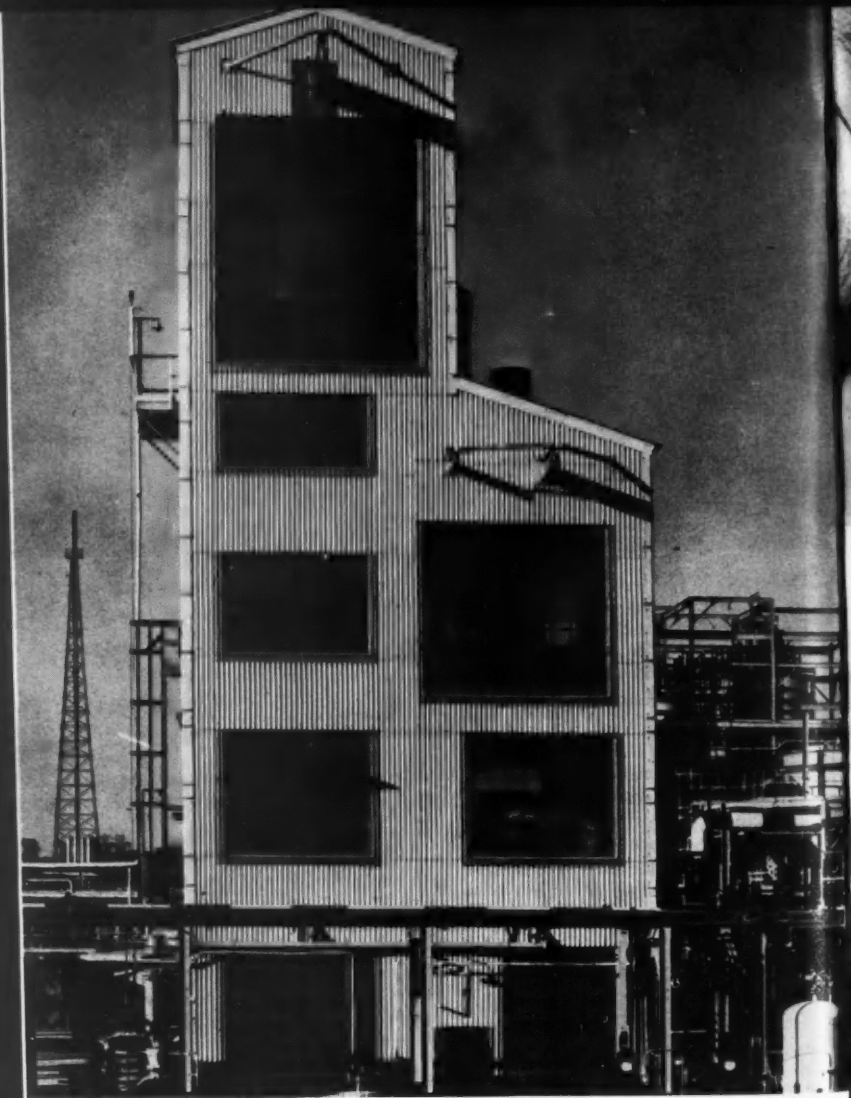
The composition of petroleum has been of interest to chemists since 1857 when Benjamin Silliman, Jr., of Yale University, made his classic analysis of the newly discovered "rock oil" from Pennsylvania.

Petroleum was an unfamiliar substance before that, although it had

been described from time to time by writers interested in natural curiosities.

Discovery of the Pennsylvania oil deposits came at a critical time. Substitutes were welcomed for whale oil in lamps and for beef tallow to grease machinery. Wheels of railroad trains especially needed lubricants. Restless Americans were moving faster and sitting up later to tell about their travels. Oil found a ready market.

But early methods of handling the unfamiliar liquid, that gushed out of the ground with such force, were crude and wasteful. Only a few years



➤ THE STILL of Esso's ethyl alcohol unit at Baton Rouge is housed in this towering building. Photograph courtesy of THE LAMP.



► BUTYL RUBBER wrapped in polyethylene film. Both these products are made from petroleum hydrocarbons, and are unlike naturally occurring materials in many important properties.

after the first oil-well was discovered, an inventor applied for a patent on a nitroglycerine torpedo to increase the flow of oil from wells that were drying up.

The highly flammable nature of the hydrocarbons composing petroleum dictated the earliest uses of the "oil" that seeps out of the ground. Changing requirements, as its use shifted from lighting to automobile fuel, caused a change in the handling of petroleum.

Coal oil, kerosene, gas—the liquid mineral has passed through the phases of use that those names signify. They were the names of fuels only. Petroleum is still the source of major fuels, but now it is much more than that.

Distillation is the time-honored method of separating petroleum hy-

drocarbons. Supplementing this, catalytic processes now attack the purified distillate fractions, of specific boiling-point ranges, and produce individual chemicals. Such compounds as iso-propyl alcohol and ethylene glycol, unfamiliar until recently, are now in daily use because of this development.

The habit of taking petroleum apart and finding uses for the different fractions became fixed about 1870, when petroleum refiners developed lubricating oils to make use of the by-products from kerosene. When the gasoline-powered automobile was invented in Europe about fifteen years later, demand for petroleum entered a phase of expansion which has been increasing ever since.

Parallel with the increased use of

petroleum has developed knowledge of the geology of oil-producing regions. Man's natural curiosity prompted him to try to find out the ultimate source of the liquid mineral as well as the appearance of the country where he might "strike oil."

Methods of spotting oilfields were worked out first. Shales and limestone were found to be the rocks in which oil originates. When geological formations occur in such a way that this oil can soak into porous sandstone and accumulate under a dome of impervious rock layers, conditions are favorable for an oil well.

The organic matter which is now the hydrocarbon oil is believed once to have formed the bodies of the small animals whose shells make up the limestone deposits. When the North American continent west of the Alleghenies was a shallow sea, myriads of these tiny creatures flourished. Their remains buried in the sandy bottom of that sea, were worked over by forces not yet completely understood. Bacteria which use sulfur compounds in their life cycles are under investigation for the role they played. Heat and pressure undoubtedly played their parts. Gas, oil and tar are the results.

Natural gas, which usually occurs with petroleum, and sometimes, occurs alone, is a petroleum product which man has had some difficulty in learning to use profitably. In the early days of oil, much of it was burned at the mouth of the well, just to get rid of it. Now, in addition to its use as fuel, much natural gas is pumped back into the oil wells. It has been found that gas and oil react with each other. The gas makes the oil less viscous, and certain oils absorb gas to

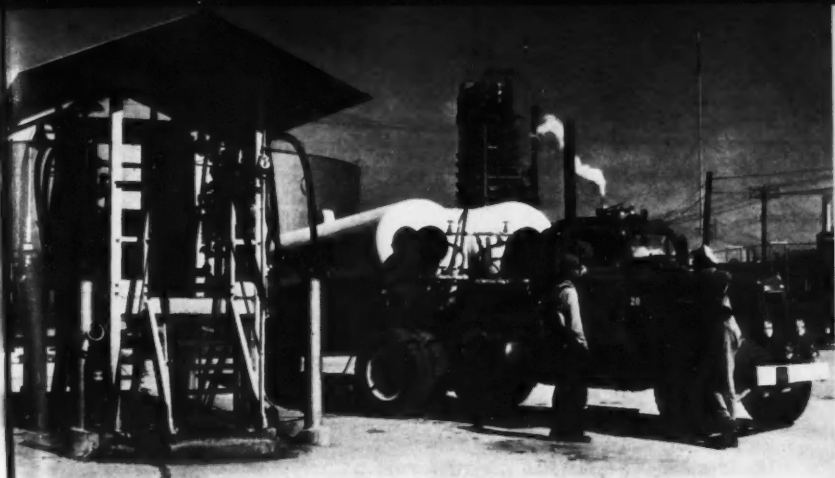
yield the motor fuel known as casing-head gasoline.

With development of the automobile, demand for gasoline soon exceeded the naturally occurring fraction of light oil in petroleum. It was then learned that heavier oils could be changed into lighter ones by the type of distillation known as "cracking." Parallel evolution of fuel and motor then began.

Higher compression in automobile engines led to discovery of tetraethyl lead, to prevent unpleasant and power-wasteful knocking in the engine. Study of purified hydrocarbons showed that octane, the molecule with eight carbon atoms, produced less knock than the others, such as heptane or nonane. It became the standard for comparison, hence the "octane number."

Airplane development has intensified the demand for "high octane aviation gas." Petroleum must now be redistributed to provide it. At the same time, new processes are constantly being developed to make usable chemicals out of those fractions of the natural oil for which there is less demand.

Destructive hydrogenation is one of these processes. Cracking in an atmosphere of hydrogen produces quantities of the gases propane and butane. These are used as fuel gases, and also as a source of chemicals, such as isopropyl and butyl alcohols. Compounds with a double bond between two carbon atoms, ethylene, propylene and butylene, can also be provided by refinery processes. These, by means of suitable conditions and clever choice of catalysts, can be made to join up into polymers.



► BUTANE-PROPANE loading racks fill tank trucks with a new hydrocarbon product, for delivery to experimentally-minded users.

Many natural materials, such as rubber, resins, waxes and other substances with similar properties, are polymers. Chemists are learning how the simple types of compounds with which they have long been familiar can be made to double up into polymerized giant molecules. In their experimenting they have come upon new kinds of materials unlike any found in nature. They have adapted many of these to make new textile fibers, various kinds of artificial rubber, new waxes, resins that can be molded into intricate shapes, products that can become as hard as metal and products that can keep their plastic consistency where that is desired.

The speed with which new chemical developments have come and the variety of new materials appearing as petroleum by-products has put many industrial companies into unexpected new lines of business.

Thus it comes about that the Celanese Corporation of America operates an oil refinery. From the process they get propane and butane, which they change into acetone and acetic acid, with which they treat cellulose to make cellulose acetate, the raw material for rayon. In the process they produce fifteen chemical by-products for which they have to find users.

The Du Pont Company, with its many chemical interests, also operates a plant in Texas. Here it makes nylon from cyclohexane from petroleum. In other processes it makes polyethylene plastic film from propane and synthetic resins from formaldehyde from methanol.

Another synthetic fiber comes from acrylonitrile made from natural gas at the plant of the Monsanto Chemical Co. at Texas City. The Dow Chemical Co. makes textile fibers and plastic film out of vinyl chloride. This ma-

terial comes from ethylene from petroleum. Another part of the ethylene they produce goes to make ethylene glycol, used as an antifreeze in automobile radiators. The Ethyl-Dow Corporation makes ethylene dibromide for Ethyl antiknock compound.

Synthetic rubber of many different formulas comes also from petroleum hydrocarbons. The important double bond between two carbon atoms in ethylene and butylene gives these derivatives the ability to form rubber-like polymers which are in some respects more useful than natural rubber. Synthetic material can be modified to fit particular needs.

Uses of chemical products also shift, according to what materials are available. When Standard Oil offered

isopropyl alcohol, which they were producing, it came to be accepted as "rubbing alcohol" in place of ethyl alcohol with its denaturant problem. When detergents came into use instead of soap, the supply of glycerine, formerly obtained from fat from the meat-packing houses as a by-product of soap manufacture, had to be replenished from other sources. Petroleum, as the new chemical storehouse, was called upon to furnish glycerine by a new synthetic process.

As processes are mastered by which the hydrocarbon oils can be modified into new and ever more useful products, new possibilities are constantly opening for more research, more applications, more interesting work for young chemists for the future.

Lignin Substitutes for Carbon

► THE RUBBER soles on shoes may soon be made partly from rubber, partly from a wood product now going to waste.

Lignin, one of the two main compounds in wood, can replace carbon black, a finely-divided form of carbon now used in manufacturing rubber. The lignin-rubber products, so far made only for test purposes, have properties just as good as, and in some cases better than, those made with the usual rubber and carbon black.

Use of now-discarded lignin with rubber to make such items as shoe soles was foreseen by Dr. J. J. Keilen of the Polytechnic Institute of Brooklyn, who described studies on rubber-lignin mixtures to members of the

American Chemical Society. W. K. Rougherty and W. R. Cook of the West Virginia Pulp and Paper Co., Charleston, S.C., assisted in the work.

The supply of carbon black is now tight and is expected to become much more critical in the coming months. Lignin is available in quantities up to about 2,000 tons a year. This is from two to four times the amount of carbon black now used by the rubber industry.

Lignin-rubber mixtures will not be used for tires for a while yet, however. There are still some properties of the combination that have to be ironed out for tire use, Dr. Keilen warned.

Technical Facts About Present Iranian Crisis

Middle East Oils

by GUSTAV EGLOFF

Presented September 12, 1951, at the Traymore Hotel, Atlantic City, N. J., before the 49th Annual Meeting of the National Petroleum Association.

► ONE of the world's greatest sources of economic wealth is the Middle East oil fields, with an ultimate potential of 200 billion barrels of oil (value over 300 billion dollars). Proven reserves are over 40 billion barrels of oil, about 46 per cent of the world's proved deposits, while the U.S.A. has about 30 billion barrels of proved oil reserves and 100 billion barrels potential. The vast oil richness of the Middle East countries, Iran, Saudi Arabia, Kuwait, Iraq, Qatar, and Bahrein is reflected in the average daily rate of production during 1950 which was 1,700,000 barrels from 315 wells averaging 5,400 barrels each. In contrast, the U.S.A. averages 12 barrels a day from its 444,000 producing wells or a total of about 5,400,000 a day.

The Middle East is vastly rich, not only in oil but in history as well. Iran, where the first commercial quantity of crude was produced, has over 6,000 continuous years of history covering five civilizations. Thousands of years ago Iran controlled the then-known world. Oil seepages and burning natural gas have been known through all recorded history, but practically nothing was done to utilize these great assets until 1855, when a British geol-

ogist reported on the scientific aspects of oil seepages of Iran and Iraq.

The first drillings for oil in Iran, made in 1891-1893 through British and German capital, ended in failure. In 1901, Iran granted a 500,000 square mile concession to an Englishman, named W. K. D'Arcy, whose company almost went broke before hitting a gusher in 1908 at a depth of 1,180 feet in Masjid-i-Sulaiman. This single oil field has produced about 862 million barrels of crude in the past 39 years.

On the basis of this discovery well, the Anglo-Persian Oil Company was formed in 1909 to operate the sixty-year concession given by the Persian government with all rights, responsibilities and obligations involved. Other oil fields were discovered in Iran, and based upon these results, oil was found in the great Kirkuk field in Iraq in 1927 followed by Bahrein in 1932, Saudi Arabia in 1936, Kuwait in 1938 and Qatar in 1940.

The development of these fields has required vast expenditures not only for oil producing facilities, but for the economic and social development of the Middle Eastern countries. Several billions have been spent, much of which has gone for non-oil producing purposes.

Beginning only 42 years ago, the Anglo-Iranian Oil Company was the

pioneer in this vast development. In 1909, the first year of A.I.O.C.'s operation, the majority of the Iranians were an illiterate, disease-ridden people, living in mud huts along with their animals, and engaged in primitive agriculture. In 1950, A.I.O.C. was supporting 200,000 people in Iran. Abadan has grown from a wilderness to a modern city complete with electric lights, treated water, a sewage system, stores, schools, restaurants, movies, swimming pools and other recreational facilities. The Company has built and equipped 30 schools which have been turned over to the educational authorities. These schools are open to the children of non-employees as well as those of employees. About 4000 illiterate adults attend each session of a special school. The Company has also equipped Teheran University with laboratories and set up a Technical Institute at Abadan. Many of the best students have been sent to English Universities for advanced training. Perhaps the most dramatic improvement has been in health standards. Back in 1909, the country was ravaged by epidemics of plague, cholera, and smallpox; malaria, dysentery and trachoma were endemic. For the past 25 years, there has been no serious outbreak of cholera or plague, and smallpox, malaria, dysentery and trachoma are under control. In 1950, over 1.5 million received attention at A.I.O.C. dispensaries and clinics, over 1 million of whom were non-employees. Without A.I.O.C., Iran would still have a largely primitive civilization. It is unfortunate that the Iranian leaders have thrown out those responsible for so much progress.

Similar developments in community

building, education and health have taken place in other Middle Eastern countries. For example, about two-thirds of the employees of the Arabian American Oil Company are Arabs. Their employment has required years of training to acquire technical skills as well as literacy. The Company has laid out a number of community developments along the Tapline as well as in the fields and at the refining, and is constructing roads across the desert to link formerly isolated localities. It is also constructing a railroad for the government. Electrical power stations and transmission lines have been built. The Company has constructed many buildings for the government and assisted in bringing in mechanized farming, irrigation, and other innovations in an effort to build up domestic industry.

The problems in connection with producing, refining and transporting oil vary with the different countries in the Middle East. The following discussion summarizes the status of the industry in each country.

The seven oil fields of Iran cover about 250 square miles of a total concession of 100,000 square miles. Proved reserves are 13 billion barrels. Operations have been carried on exclusively by the Anglo-Iranian Oil Company. The only other active oil company is the Iran Oil Company, formed by the government in 1949 to explore outside A.I.O.C.'s 100,000 square mile concession.

Daily production in 1950 was at the rate of 665,000 barrels from 77 wells, or over 8,500 barrels per well per day. The greatest oil field in Iran is the Agha Jari discovered in 1937. At the end of 1950, production was 370,000

barrels a day from 16 wells, or an average of 23,000 barrels per well per day. The gravity of the various crudes ranges from 33 to 43 API, averaging 37.

The depth of wells ranges from about 2,000 feet to 5,500 feet. Production is from limestone formations of phenomenal thickness, varying from 600 to 1500 feet.

The flow from wells having pressures around 2000 p.s.i. has been very carefully controlled so that pressure drops are about five pounds per well per year. Excess gas was pumped back into the formation. The most modern techniques known to science were used. It is believed that 90 per cent of the oil in the formations can be recovered. The result is long-lived fields — as witness the Masjid-i-Sulaiman which, after 39 years, is producing an average of 2100 barrels per well per day.

The pipeline system is interlaced from field to field to the Abadan refinery and Bandar Mashur, both export terminals. The modern refinery at Abadan, the largest in the world, is a complete one which processed about 560,000 barrels of crude into 90,000 barrels a day of motor fuel, 18,000 barrels a day of aviation gasoline, as well as kerosene, Diesel oils and jet fuel. Operations included a 35,000-barrel-a-day fluid catalytic cracking plant, three alkylation units and a 400 barrel-a-day lubricating oil plant, etc.

One of the most important segments of the Anglo-Iranian Oil Company's operations is transportation. It owns one of the world's largest tanker fleets consisting of about 160 ocean-going tankers and charters another 160

ocean-going tankers, having a carrying capacity of 2,000,000 dead weight tons of oil, and chartering another 2,000,000 tons — or a total of 4,000,000 tons.

Very little oil is required for the 18,000,000 people in Iran, and about 97 per cent of the crude oil and refined products produced in Iran has been exported. All exportation is dependent upon shipping and thus the tanker fleet is a vital part of their world-wide operation.

It is unfortunate that the highly integrated and efficient operations of A.I.O.C. in Iran have been lost to the world even if only for a temporary period of time. It is hoped that efforts being made towards a satisfactory solution to the problem will soon restore the Anglo-Iranian production of refined products and crude oil to world markets.

Iraq

The geological conditions of Persia were found to be continued into Iraq. This called for further exploration, which resulted in the discovery of the great Kirkuk field in the year 1927, although production was not commenced until the latter part of 1934. The land area of Iraq is about 116,000 square miles and has a population of 5 million. The proved oil reserves of 8.25 billion barrels occupy an area of 132 square miles. There were ten wells, producing 159,000 barrels daily at the end of 1950, or at the rate of about 16,000 barrels per well per day. There are also twenty-nine shut-in wells and fifteen observation wells. The producing wells are derived from an average 800 feet thickness of pay limestone. The API gravity of the oil from this field is 36.

The production of Iraq has come entirely from the Karkuk field, although some heavy oil has been discovered in the Mosul area from shallow wells; i.e., less than 1000 feet. The API gravity of this crude is about 20. The new Basrah field will be in operation shortly when the pipe line is finished to Fao on the Persian Gulf.

Operations at the Kirkuk field are carried on entirely by the Iraq Petroleum Company which is owned by Anglo-Iranian, Compagnie Francaise des Petroles, Royal Dutch-Shell, Near East Development Corporation (Standard Oil (N. J.) and Socony-Vacuum) each having 23.75 per cent interest and C. S. Gulbenkian who holds 5 per cent of the shares. This company was formed in 1928 and marks the first participation of American oil companies in Middle East operations.

Refining capacity in Iraq is small and most of the oil produced must be transported elsewhere. The only means of transportation is by pipeline. The first lines were built in 1934. These included two 12" lines from the Kirkuk field to the Mediterranean. One is 620 miles in length to the refinery owned jointly by Anglo-Iranian and Shell at Haifa, Palestine, and the other is 532 miles in length to Tripoli, Lebanon.

About four years ago, construction was begun on parallel 16" lines. The line to Tripoli was completed and, along with the older 12" line, is carrying its capacity of 160,000 barrels per day. The 16" line to Haifa has not yet been completed because of the Arab-Israeli conflict. When completion is allowed and the old 12" line to Haifa is again in operation, the

total carrying capacity will be 150,000 barrels per day.

A 30" pipeline from Kirkuk to Banias, Syria is now under construction which, along with other lines to Haifa and Tripoli, will bring transportation from Iraq to a potential of 610,000 barrels per day. Completion of this line is scheduled for July, 1952.

It is hoped that the Haifa, Palestine, refinery, jointly owned by Anglo-Iranian Oil Company and Shell Company, which has over 85,000 barrels a day capacity, will receive the Kirkuk crude which is now shut off by order of Iraq. Haifa's source of oil through the Suez Canal from the Persian Gulf has also been cut off. It is receiving about 20,000 barrels a day by tanker transportation around Africa and through the Mediterranean, or from Venezuela. At present it is receiving crude from Venezuela.

Saudi Arabia

The king of Saudi Arabia granted a concession to the Standard Oil of California in 1933, which was assigned to the Arabian American Oil Company in 1939. The company is owned by the Standard Oil of California, the Texas Company, and the Standard of New Jersey, each holding 30%, and 10% by the Socony-Vacuum Oil Company. The concession covers an area of about 440,000 square miles, which is greater by 15,000 square miles than the States of Texas and California combined. Exploration and drilling were started in 1933. The results were most discouraging until 1936 when the Damman field was brought in. The daily production of Saudi Arabia at the end of 1950 was 618,000 barrels a day, which was stepped up during

July of this year to an average of 820,000 barrels per day. Proved reserves have been estimated at 9.2 billion barrels, but new fields are being discovered from time to time.

There are three oil-producing fields, with a total of 103 producing wells averaging about 6,400 barrels per day per well. Their depth ranges from 4,200 to 10,000 feet. The largest of these fields is the Abqaiq, which is producing an average of about 500,000 barrels per day. The Ain Dar pool, discovered three years ago, is believed by some to be one of the largest fields ever found. Production has been averaging 129,000 barrels per day, but will be increased greatly in the near future. The oil pay thickness of Arabian wells ranges from 120 to 400 feet.

A new oil field was also discovered about two miles out in the Persian Gulf. This means a second new field this year, or a total of nine. The estimated proved area of the nine oil fields is approximately 300 square miles.

Aramco has a refinery located at Ras Tanura, which was built for military purposes in 1943-45. A substantial portion of the output of the refinery is for the United States Navy. It had a crude run of 157,000 barrels per calendar day for the first six months of 1951, and more recently has been operating at even higher capacities to offset particularly the loss at the Abadan refinery in Iran.

The population of Saudi Arabia is estimated to be 6,000,000 more or less, and domestic consumption of oil is small. The major part of the production and products is exported.

One of the greatest engineering feats of our time has been the Trans-

Arabian pipeline which was completed in 1950 at a cost of about \$230,000,000. This 30"-31" pipeline is 1,068 miles long, and extends from the Persian Gulf through boiling desert to Sidon, Lebanon, on the Mediterranean. Entirely new ideas and tools had to be developed to cope with the unique conditions of sand, rock and heat. The desert fleet of trucks and cars consisted of more than 1,500 units including giant 50-ton truck-tractors for hauling the pipe, trailers, refrigerator trucks and many other types of vehicles.

The capacity of the pipeline is over 300,000 barrels a day which could be increased by additional pumping equipment. This pipeline eliminates a 20-day, 7,000-mile trip around the Arabian peninsula through the Suez Canal into the Mediterranean and return. It replaces sixty-five tankers and saves large sums in toll. The Suez Canal carries a toll of 18 cents a barrel — hence, a daily saving of \$54,000 on that expense alone.

Kuwait

The tiny sheikdom of Kuwait, has an area of about 6,000 square miles and only 100,000 or so inhabitants. The entire sheikdom is under lease to the Kuwait Oil Company, owned 50-50 by the Anglo-Iranian Oil Company and the Gulf Oil Company. A 75-year concession was granted in 1934.

The Burghan field, which is the only one producing at present, was discovered in 1938 at a depth of about 3,700 feet. It was considered the largest single oil field ever discovered in the world. The Burghan field has estimated proved oil reserves of 15

billion barrels in about 90 square miles. By comparison, the famous East Texas field is estimated to have had only 5 billion barrels at the outset.

Kuwait operations were almost discontinued in 1942 because of the war and actual commercial production did not begin until 1946. In July, 1951, 650,000 barrels a day were produced from 94 wells, or an average of about 7,000 barrels per well per day, with 16 wells kept in reserve. The crude is being produced from an oil sand of over 1,100 feet thick. Dr. G. M. Lees, chief geologist of the Anglo-Iranian Oil Company, stated: "The Burghan field of Kuwait, for example, has about 800 feet of effective sand distributed through 1,100 feet of section — clean quartz sandstones of optimum degree of porosity and permeability. It would almost seem that a beneficent providence intended the region to be richly oil-bearing. In a region which elsewhere has a dominant calcareous regime, suddenly sandstones appear, but sandstones of an excellence as reservoir rocks almost without parallel in oil-field experience."

A 25,000-barrel-a-day refinery is now in operation in Kuwait to supply local needs and fuel for visiting tankers. Export at present is by tanker only, but a pipeline project has been under discussion to transport the oil from Kuwait on the Persian Gulf to the Mediterranean.

Qatar

The sheikdom of Qatar is a small peninsula of 4,500 square miles, jutting out from Arabia into the Persian Gulf. The population is probably about 10,000. The Petroleum Develop-

ment Company (Qatar), Ltd., composed of the same companies owning Iraq Petroleum Company, has a 75-year lease on the entire peninsula. By later agreement, all offshore territory within three miles is included. Offshore territory from three to twelve miles is included in a concession held jointly by the Superior Oil Company and the Central Mining and Investment Syndicate, a London firm.

Oil was discovered in the Dukham field in 1939. Only two wells were drilled before the war and these were plugged until 1947. In 1950, production averaged 33,000 barrels daily and 1951 output is something less than 50,000 barrels per day — about 50 per cent more than in 1950.

Bahrain

Bahrain is a small insular sheikdom about 210 square miles in area with a population of 120,000. This group of small islands is about 20 miles off the Saudi Arabia shore. A concession was granted to Bahrain Petroleum Company, owned by Standard Oil of California, the Texas Company later joined the Standard of California in the ownership of Bahrain in 1930. The original concession has been extended to cover the entire sheikdom until 1995. It was the first wholly American oil venture in the Middle East.

In 1932, the first well was brought in. The field now consists of 69 wells and production is slightly over 30,000 barrels per day or an average of some 440 barrels per day. Total production in 1950 was 11,015,711 barrels.

The Bahrain Island refinery is now one of the most important in the Middle East. Its capacity exceeds 175,

000 barrels per day. It processes the entire Bahrain production and more than 145,000 barrels of crude which comes from Saudi Arabia. Facilities include thermal and catalytic cracking units, aviation gasoline manufacturing units, an SO₂ plant, an asphalt plant and others.

Exports to Europe

The largest market, for Middle Eastern oil is Western Europe (outside of the Iron Curtain). Just before the Iranian crisis, 875,000 barrels of crude oil or about 44 per cent of the total production was being exported to Western European refineries. Of this total, 125,000 barrels of crude came from Iran. Exports of refined products were at the rate of 175,000 barrels per day from the Middle East, 135,000 of which come from Iran. These exports of crude oil and refined products accounted for about 90 per cent of the total West European demand. Increases in exports from countries other than Iran will be necessary not only to make up the deficit caused by loss of Iranian crude and refined products but also to meet growing West European demands. The rise in demand will be principally for crude oil to feed European refineries now being constructed. The vast refining expansion program will be discussed.

European Refineries

In western Europe most of the refinery capacity was destroyed by bombing and after the war rehabilitation of old and construction of new refineries was needed to assist economic recovery. European nations wanted to be self-sufficient in regard to refined oil supplies, and the ECA was willing to assist in the refinery

expansion program. It was believed that if European imports of refined products could be minimized and crude oil imported for refineries to manufacture such products for domestic consumption, the dollar shortage in Europe could be greatly lessened and a better trade balance established. Of the \$235 million capital expenditures necessary for refinery expansion, the ECA has supplied \$35,000,000 up to December 31, 1950. A major portion of the refinery expansion has been made by European subsidiaries of U. S. companies.

The Oil Committee of the Organization for European Economic Cooperation has kept close control over the European refinery expansion programs. It has required that all projects be submitted for approval before construction is begun and also that no construction be started within four months from the date of submission of estimates. It has also required that refinery programs be integrated to avoid duplication of refinery facilities, that expansion be restricted to take care of no more than indicated market demand and that no trade barriers be set up to obstruct free markets. It has also recommended that refinery design and construction employ American technical assistance, and consequently, most of the new European refineries are of American design. The Oil Committee has also recommended that European manufacturers be allowed to make as much refinery equipment as possible. Another requirement which has been insisted upon is that European refiners do not start an octane race, with consequent increase in the cost of gasoline production. . . . As a result of the modern refinery ex-

pansion program, the United Kingdom, France, Italy, Western Germany and Holland will soon be able to supply their domestic demands for refined products from their own refineries. In the United Kingdom, large refinery expansion projects are under way at Fawley, at Llandarcy in Wales, at Grangemouth in Scotland and in Kent. The Fawley refinery, the largest in Europe, is being constructed by the British subsidiary of the Standard Oil Company of New Jersey, and will shortly be in full operation. It operates on Middle East crudes and will require 126,000 barrels per day. The catalytic cracking plant has a capacity of 41,000 barrels a day. The lubricating oil capacity will be 4,000 barrels a day. Two thermal reforming units will be used to improve the octane rating of straight-run gasoline.

In France 300,000 barrels a day of crude oil were refined in 1950, 27 per cent more than in 1949. For the year 1950-51, 360,000 barrels per day were

processed. French refineries are now supplying all of the domestic demand for refined products with the exception of small amounts of specialties and are exporting to adjoining countries as well.

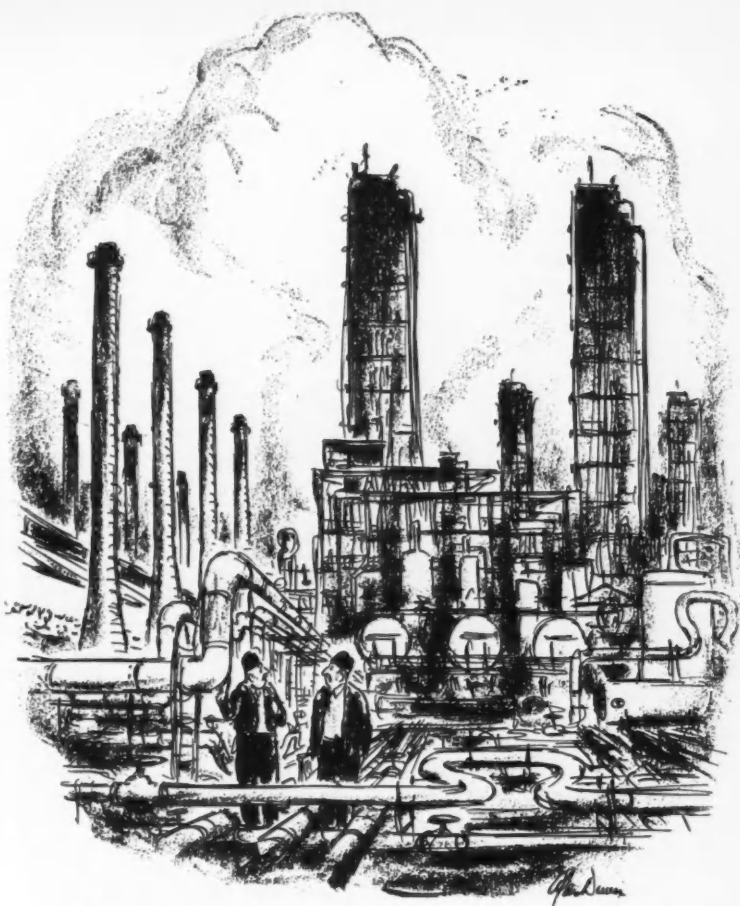
Germany's total refining capacity will be 127,000 barrels per day in 1952-3. The refineries include facilities for hydrogenating 30,000 barrels a day of residual fuel oil. By 1952, it is expected that present cracking capacity of 20,000 barrels a day will be increased by an equal amount in thermal cracking and 24,000 in catalytic cracking capacity. Germany has the largest lubricating oil capacity in Europe, 9200 barrels a day.

In Italy the refinery capacity is to be augmented by 40,700 barrels per day to reach a total of 193,800 barrels by mid-1953. At five different localities, new units are planned or under construction. The largest of these is at Milan, where the capacity will be 30,000 barrels a day.



On the Back Cover

➤ ETHYL ALCOHOL, instead of being the product of the lowly yeast, comes from this maze of pipes and vats at the Chemical Products Division of the Esso Standard Oil Co. refinery at Baton Rouge, La. All photographs are courtesy the Standard Oil Co. of New Jersey.



—Reproduced by permission. Copyright 1951. The New Yorker Magazine, Inc.

"Should it gurgle?"

**More Gas For Cars
When Buses Use LPG**

Bottled Gas For Buses

by A. C. MONAHAN

► ONE WAY to conserve gasoline for automobiles and airplanes is to use "bottled gas" for fuel in city buses. Millions of country homes are now using it for cooking. A goodly number of buses are now using it as fuel, enough to prove that it provides satisfactory and economical power.

"Liquid petroleum gas" is the name by which this fuel is known in the oil industry. It is called LPG for short. Chemically, it is composed of propane and butane. These gases come to the surface of the ground along with the petroleum in many oil fields. They are also produced as a by-product in the manufacture of gasoline. They can be liquefied by pressure and shipped and used from portable tanks with safety.

In early days in the oil industry the gases that came to the surface with the crude oil, and by-product gases at refineries, were burned in the open because no uses for them had been found. Although there are now many known uses, much is still wasted. Recovery today is only about one-fourth the amount available, it was recently stated by scientists of the Phillips Petroleum Company, Bartlesville, Okla.

These same scientists estimated that there are nine gallons of LPG available from our current petroleum reserves for every 10 gallons of gaso-

line. Full recovery and use, they recently told the American Petroleum Institute, would increase the life of our petroleum reserves by more than 50%.

LPG produced at refineries often contains propylene and butylene as well as the principal constituents, propane and butane. The combination is just as good, as a fuel. According to scientists of the Esso Standard Oil Co., N.Y., LPG is less expensive than gasoline and gives better mileage per gallon. It is clean burning fuel, permitting operations with an absence of disagreeable exhaust odors.

Experiences in operating buses with LPG were recently discussed by Robert S. Lee, Twin Coach Company, Kent, Ohio. Internal-combustion engine designers have long recognized the need for a fuel which possesses high-octane rating, resistance to detonation, and ideal combustion characteristics. Propane, a common liquefied petroleum gas, possesses these advantages, he said. The propane fuel system is not complex, he added. The use of propane as an engine fuel promises the commercial fleet operator lower fuel costs, maintenance savings, the widest possible safety in handling, plus public acceptance.

LPG for bus power is not exactly new but bus companies throughout



► *TYPICAL Texas skyline bristles with towers for new petroleum by-products.*

the country are now giving it more attention than ever before, perhaps due to the increasing cost of gasoline and threatened shortages. It has been in use on the Pacific coast area for nearly 20 years in heavy trucks, off-the-road vehicles, rail cars and industrial engines. One bus line in Spokane, Wash., has used the gas for over ten years.

No attempt will be made here to list cities now using bottled gas for bus power but the growing use is indicated by announced intentions. It was reported early this year that Capital Transportation Co., Little

Rock, Ark., had ordered 15 propane motor coaches. The company also plans to convert 25 of its present buses to propane burners.

Kansas City Public Service Company has converted, or is converting, 114 of its 288 buses to propane burners. It is also buying 30 new coaches with propane-burning fixtures. Northern Transit Company has 16 buses using propane on its Fargo, N.D.-Moorehead, Minn., run.

LPG is suggested for city buses, and trucks also, because supplies of the bottled gas ready for installation in them can be easily accessible. This

gas, under high pressure in liquid form, is transported from field or refinery in tank trucks and railroad cars. At local centers, it is transferred, still under pressure, to storage tanks, and from them into the small tanks which are delivered to homes or used in the buses.

Ordinary automobiles can be converted to use LPG as a fuel but it is not expected that many will be in the immediate future. Most car owners take more or less frequent long trips into country districts where gasoline stations are plentiful but LPG replacements not available. The principal conversion change necessary is the replacement of the ordinary carburetor with a special type. Space for the tanks and connections to the carburetor are also needed.

Not all engines can be changed to the higher compression ratios best for liquid petroleum gas. Theoretically, the heat value of chemically correct air-fuel mixtures of propane, butane and 100-octane gasoline respectively in a gaseous state at atmospheric pressure and temperature are essentially the same. The same output from the three fuels might be expected at a given compression ratio, other things being equal.

However, gasoline enters the engine induction system as a liquid. Its vaporization after mixing with air lowers the temperature of the air-fuel mixture approximately 50 degrees Fahrenheit. Since propane as a fuel becomes vaporized before it is mixed with the air this drop in temperature does not occur.

Propane has a slightly higher heat-content per pound than gasoline and

diesel oil. However, because only about two-thirds as heavy as gasoline, it has less heat energy per gallon. Higher compression engines are needed, with their better thermal efficiency, to recover some of the differences between a gallon of propane and a gallon of gasoline.

Cost of the fuel is an important factor in determining whether LPG or gasoline should be used in buses. In the oil-producing Southwest, LPG is up to seven cents per gallon cheaper than gasoline according to a recent study. A bus company in Chicago is buying LPG for eight to nine cents a gallon, it is reported. In the northeast area, it should be higher because of the long haul.

Safety and legal aspects of LPG have given concern to many. Some 37 states, mostly in the West and Midwest, have legal codes permitting its use subject to certain regulations such as those of the National Bureau of Fire Underwriters. In other states there are local ordinances concerning LPG use.

This compressed gas when released into the atmosphere is extremely flammable. Great care has to be taken, therefore, to eliminate the possibility of leaks by the use of suitable equipment and proper maintenance and operation of automotive vehicles. If a leak did occur, the consequences could be serious because the gas is under pressure in the entire system.

The National Automobile Underwriters Association has been studying the situation for some time to determine if higher insurance rates should be fixed for motor vehicles powered with LPG compared to those

for gasoline-powered motor vehicles. Present rates remain the same, indicating that greater hazard from LPG than from gasoline has not been established.

In addition to providing power for city vehicles, there is a large rural field in which liquid petroleum gas may play an important part in the near future. It is on the farm, to power tractors and other equipment. Areas of the rural United States, to which bottled gas for household purposes is now delivered by fuel companies, could easily receive additional supplies for farm machinery.

Wide usage of LPG in farm equipment would please the LPG industry because it would balance the delivery load. Much more bottled gas is used for household purposes during winter months than in summer because of cooking, lighting and heating needs. The use of LPG-powered farm machinery would more nearly balance the year-around load.

Some distributors of bottled gas are encouraging farmers to convert from diesel or gasoline power by providing the equipment necessary on tractors and other machines to make the conversion. They do not charge the farmer cash for the installation or for the carburetor. But they do charge a little extra for the liquid gas until enough has been paid to compensate the distributor for the tractor accessories.

This farm field is a potential big market for LP-gas. Relatively few horses are now used on American farms in comparison with the number used formerly. Gasoline is the principal fuel used, with diesel oil to a lesser extent. Conversion of farm equipment to LPG would mean that great quantities of gasoline would be available for other purposes. The 40,000,000 motor vehicles on American highways, and the vast number of airplanes in the sky are creating an ever-increasing demand for more and more available gasoline.

Pressure Solidifies Rare Helium 3

► A RARE form of the element helium—one that can not be frozen simply by cooling it to a low temperature, has finally been solidified. Pressure plus a low temperature of 457 degrees below zero Fahrenheit did the job, D. W. Osborne, B. M. Abraham and B. Weinstock, of the Atomic Energy Commission's Argonne National Laboratory, reported to a recent symposium on low temperature physics.

The helium 3 was put under a pressure of 600 pounds per square inch before it solidified at this low temperature. Small quantities of the material were frozen in a tubing about the thickness of a human hair. The helium 3 is available as a decay product of radioactive hydrogen, or tritium, one of the materials mentioned for the H-bomb.

A shortage of sulfur makes a shortage of sulfuric acid, an essential chemical in many industrial processes.

Petroleum Fuels Face the Future

► EMPHASIZING the rapid growth of the domestic fuel oil business in the past 25 years, Dr. J. Bennett Hill, director of the chemical and engineering division of the Sun Oil Company's research and development department, Marcus Hook, Pa., told the American Chemical Society that this development has posed many problems for the burner industry and the petroleum refiners. As with the automobile engine and its gasoline, the oil burner and its fuel must be adapted to each other, Dr. Hill said.

The three primary oil burner types are: (1) The vaporizing burner which vaporizes the fuel on a hot surface or by radiant heat, and burns it as a gas. This burner requires a fairly volatile, clean-vaporizing, clean-burning fuel. (2) The atomizing or gun-type in which fuel is atomized either by high pressure solid injection into the air stream, or by mixing with the air at low pressure and obtaining air atomization at the nozzle. These burners are more tolerant of heavier, lower volatility fuels. (3) The wall flame rotary burner in which fuel thrown from a distributing head as a coarse spray strikes a vaporizing ring, is ignited, and burns.

Domestic fuel oil originally was almost exclusively a straight-run or virgin fraction from petroleum, with a boiling range like kerosene or somewhat higher. Because of variations in the burning qualities of the various fuels supplied, three classifications of

fuel oils were adopted in 1929. Two of them, namely fuel oil No. 1 and fuel oil No. 2, still exist.

Under the 1948 Commercial Standard CS-12-48 specification, fuel oil No. 1 is defined as intended for vaporizing pot-type burners and other burners requiring this grade, whereas No. 2 is defined as for general purpose domestic heating for use in burners not requiring No. 1. No. 1 fuel is therefore to have a low 10 per cent point, a low end point, and low carbon residue to ensure quick starting and clean vaporization, while with No. 2 fuel, which is burned as an atomizing spray, these qualities are given wider latitude.

In accordance with the above mentioned specification, fuel oil No. 1 has continued to be a straight-run fuel approaching kerosene in its properties. This fuel is also a high grade Diesel fuel, and excellent cracking stock for gasoline. Its popularity, therefore, is primarily dependent upon economics.

With fuel oil No. 2, refiners, recognizing the competition of straight-run fuel with its use as cracking stock, started to incorporate cracked stocks into the product. At present at least 70% of the No. 2 fuel is cracked stock. Because of the additional B.t.u.'s in the lower American Petroleum Institute gravity cracked stocks, the customer gets more B.t.u.'s for his money, but burner manufacturers must design their equipment to

handle the slower burning and longer flame.

The use of cracked stocks in fuel oil No. 2 has presented the refiner with a stability problem because there are compounds present which, on aging, will form insoluble sludge. This sludge may clog burner screens and may eventually result in trouble. Very little has appeared in the literature on the chemistry of sludge formation in these oils other than that certain compounds of sulfur and nitrogen appear to increase the quantities of sludge formed. Indications are that condensation or polymerization do not play a conspicuous part.

Refiners have attempted to combat sludging troubles by various methods including the elimination of those cracked stocks tending to form sludge from the blend, and chemical treatment such as with caustic soda or sulfuric acid. An interesting recent development is the use of additives which act either to inhibit the reaction which forms sludge, by means of a stabilizing additive, or peptize the sludge in such a way that it does not plate out on the screens. Amino compounds are prominent in the first group, while metal soaps are examples of the second type.

Indications are that the present popularity of the oil burner is primarily due to its convenience. The interest of the oil heat industry is to ensure that the technology of oil burning is made as simple and convenient as possible for the household. Continuance of the existing co-operation between equipment manufacturers and petroleum refiners should ensure this.

Tetraethyllead Still Good

➤ **MORE POWERFUL** automobile engines and better gasolines are on the way, but no radical overnight developments are anticipated, Dr. Graham Edgar, vice-president of the Ethyl Corporation, told the American Chemical Society at a symposium of the Society's Division of Petroleum Chemistry on "Twenty-five Years of Progress in Petroleum Technology."

Already, he said, new engines have been designed which are actually high-compression engines—engines which operate at much higher cylinder pressure and develop more power—but they cannot be run efficiently with present gasolines.

Dr. Edgar predicted that suitable gasolines will be evolved, although he conceded that this step probably will be followed in turn by the design of still more powerful motors.

Since the introduction of tetraethyllead as an antiknock agent for gasoline in 1923, its use has grown steadily until today practically all United States motor and aviation gasolines contain it, and many foreign gasolines as well, Dr. Edgar said. This progress has not been without opposition and difficulties. At one time, few motor manufacturers approved its use despite its potential advantages, because of its real or fancied effects upon engine parts, and it is a tribute to the real value of the product that intensive work to correct such problems as actually existed has been done and is being done by the automotive and aircraft industries, the petroleum industry, and the producers of tetraethyllead.

When the decision was made more

than 25 years ago that tetraethyllead was the most promising antiknock to commercialize, the data were very scanty in comparison with our knowledge today, yet even if we were beginning all over again we would still select tetraethyllead. The original selection of tetraethyllead may be regarded as a stroke of genius, good fortune, or both, for it has about the maximum antiknock effectiveness among the lead alkyls; it possesses good stability; its volatility is a happy compromise between the high value desirable for use in the fuel and the low value desirable for safety in manufacturing and handling; and its cost is also about the minimum.

Although no more practical antiknock is now known than tetraethyllead, it cannot be said that all of its properties are ideal for its purposes. Its less desirable properties are its toxicity, low volatility, sensitivity to sulfur, and its effects on engine deposits.

Oxidation or combustion of any fuel and oil in an engine tends to form troublesome deposits on all exposed parts: intake and exhaust valves and manifolds, combustion chamber, spark plug, piston, cylinder wall, and crankcase. The presence of tetraethyllead fluids may aggravate these troubles, may have no effect, or may even lessen them. During the past twenty-five years, tetraethyllead has frequently appeared to be the "whipping boy" for almost all deposit troubles, and it has required extensive and continuing research to develop the true facts, the problem being complicated by the interrelationship of tetraethyllead, fuel, oil, engine design, and operating conditions. To-

day, the broad problem of all engine deposits is well recognized by both the petroleum and automotive industries, as well as by the suppliers of antiknocks. Cooperative work is in progress to find practicable means of solving the various problems one by one.

Probably the most serious effect brought about by deposits is the increase in octane number requirements of the engine. This increase averages about 10, but may be as great as 25 or 30 octane numbers in extreme cases. The effect, however, is practically independent of the presence or amount of tetraethyllead in the fuel.

Major steps toward solving the general problems of deposits have been made: (1) by engine manufacturers through selection of engine designs, materials of construction, and maintenance procedures which make engines less sensitive to fuels, lubricants and additives; and (2) by petroleum refiners through selection of fuels, lubricants and additives which are compatible.

In general, it would appear that some degree of trouble must always be expected from deposits. However, progress has been made to the point where the present problems cannot be regarded as critical. Moreover, present research indicates that there is hope for substantial further improvement. In any case, the extent to which tetraethyllead contributes to these problems is a small price to pay for its value as a fuel constituent.

The high output and excellent economy of the high-compression engine have been long known and the average compression ratio of automotive engines has increased steadily during

the past twenty-five years. However, as a result of developments in the production of high antiknock fuels within the last few years, new engines have been designed which are really high-compression engines, built to permit operation at compression ratios well above those permitted by present gasolines. The trend appears definitely to be in the direction of Vee engines of short stroke, with well-cooled overhead valves, and with combustion chambers designed as far as possible to minimize the antiknock requirement of the engine on a given compression ratio.

The principal limitation on increases in compression ratio is the requirement for high antiknock fuel. Engine designers are well aware of this, and large amounts of research are in progress on so-called "mechanical octane numbers," that is, any means of lowering the fuel antiknock requirement for a given engine performance or, preferably, of increasing the performance for a given antiknock level.

It may be concluded that much progress will be made in reducing the fuel antiknock quality required at a given engine compression ratio. However, it seems likely that such progress will be utilized by engine manufacturers to increase compression ratios, be-

cause of the fuel economy and engine performance to be gained thereby. The end result will be a demand for fuel of still higher antiknock quality rather than a reduction from present levels.

Among the possibilities for further improvement in the utility of tetraethyllead in motor gasolines at high antiknock levels are at least three: (1) development of still "milder" engines for best use of sensitive fuels with tetraethyllead; (2) discovery of economical means of reducing the sulfur in gasoline to very low levels or of otherwise minimizing its deleterious effect on tetraethyllead; (3) production of base gasolines which, blended with tetraethyllead, will give higher road antiknock values than indicated by conventional laboratory test methods.

The trends of the past 25 years toward increasingly better quality gasolines and concurrent improvement in engine performance are expected to continue. Improvements take time and no radical overnight developments are anticipated. Much further research, design and investment will be needed, but the end of the road is not in sight and the petroleum and automotive industries are not apt to stand still so long as progress is possible.

Unbalanced Equations Could Be Worse?

► REACTIONS to penicillin may range from a welt on the injection site, to hives, to death from anaphylactic shock. None of the reactions he reviewed, however, was fatal.

—*The Washington Post*

Manufacturers Show Chemicals And Machinery to Make Them

Chemicals on Parade

► MIXERS, filters, centrifuges and pumps will be featured performers as the 23rd Exposition of Chemical Industries opens in Grand Central Palace, New York City, on November 26. As usual, the "general public" and all persons under 19 years old are excluded. The exposition is a buyers' fair.

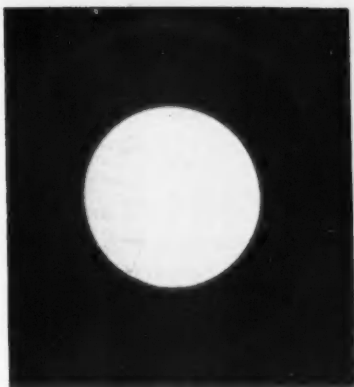
New instruments for analysis and control accentuate the modern trend toward automatic processing. Corrosion resistant containers, pipes and, especially, valves offer improved service in handling "hazardous, lethal and malodorous fluids." The management of the exposition explains the purpose of the show by pointing out the difference between chemical and mechanical industries.

Chemical industries are differentiated from mechanical industries principally in the respect that their performance depends on changes in the molecular structure of materials which alter their characteristics and behavior. By contrast, mechanical industries deal with physical changes, often limited to changes of outward form, but not of the cellular or granular microstructure, which is the field of chemistry. To the chemist, every recognizable substance throughout the universe is raw material, to be broken down and reconstituted when and as required, and as methods can be evolved. The chemist lives in the laboratory but it is the function of the chemical engineer to expand the

chemist's achievements to the larger proportions of the industrial scale. It used to be that a quarter of a century or more might elapse between the announcement of a discovery or a major invention in the field of chemistry and its realization in terms of practical value to the public, but now, with rapid communications and the common meeting of minds trained in the professions, the gap between discovery and realization has been reduced to a decade, to five years and sometimes to no more than a year or two. More new things are coming out today than ever before.

Visitors qualifying for admittance to the Exposition include chemists, chemical and mechanical engineers, scientists, members of research groups, research institutions, institutions of learning, executives, consultants and production specialists, economists, representatives of investment and banking institutions, department heads and staff engineers from many industries having no nominal ties with the work of the chemist. Registrations are recorded from all parts of the United States and from many parts of the world.

The Advisory Committee of the Chemical Exposition is composed of men of recognized standing in their respective fields. The Advisory Committee of the 23rd Exposition is under the chairmanship of E. R. Weidlein, director of Mellon Institute.



➤ **THULIUM** gives off gamma rays soft enough to show the internal structure of an aluminum casting, which is transparent to most nuclear radiation. This is the first successful radiograph and photograph of such a test, made by Dr. Robert West at England's atomic research headquarters. This photograph is also appearing in NUCLEONICS.

Rare Metal Inspects Aluminum

➤ **METAL CASTINGS** of light alloys can now be inspected successfully for dangerous defects through use of gamma rays from a rare \$7,000-per-ounce metal irradiated in an atomic furnace.

This major problem of the metallurgical industry was solved by the work of a British atomic scientist, Dr. Robert West, of the Atomic Energy Research Establishment, Harwell, England, who announced his discovery to an international meeting of scientists in Oxford.

Radiography, taking X-ray-like pictures, of aluminum alloy castings has not been possible because the rays from most radioactive elements are too penetrating.

Dr. West uses the rare earth metal,

thulium, in the form of the oxide Tm_2O_3 . When irradiated in the Harwell atomic pile it becomes radioactive ($Tm-169$ (n) $Tm-170$) and then gives off softly penetrating gamma rays which are of the right intensity for making a full detail radiographic picture of a one-half inch aluminum alloy casting.

Radiographs of castings, like X-ray pictures, show the condition of the walls and reveal any structural defects before they have a chance to cause serious trouble in use.

The metal industry has been using radioactive cobalt, tantalum and iridium for taking radiographs of iron and steel pipes, engine blocks and

other castings, but the rays from these elements are so penetrating that they are useless for the alloys of the light metals and are even too strong for

steel of less than one-half inch thickness.

Radiothulium has a useful half-life of over 100 days.

Ozone Bothers Rubber Chemists

► OZONE of the atmosphere is universally detested by rubber chemists, because it attacks rubber goods, causing checking and cracking which either makes the article fail or the customer complain. Ozone is a special form of oxygen generated by light of short wave length in the upper atmosphere, which reaches the lower atmosphere in such limited amounts that it is measured as a few parts per hundred million. Nevertheless, that is of sufficient quantity to do considerable damage to vulcanized rubber when the latter is slightly stretched. This conclusion was reached by A. W. Bartel and J. W. Temple of the U. S. Rubber Co., who reported their ozone survey to the American Chemical Society. Los Angeles is one of the areas where such ozone damage to rubber has been heaviest. It was believed that determination of the ozone concentrations over a considerable number of months might contribute background knowledge for better understanding of the problem.

Such determinations were run in considerable number for over a year in Los Angeles, mainly through 1949. There is a certain doubt that the results may have been inflated by certain impurities which acted like ozone toward the chemical reagent; nevertheless, it was shown rather clearly that average ozone concentrations of

the atmosphere around Los Angeles in 1949 were several times higher than, for example, in Detroit, Mich. in 1951, or in Murray Hill, N. J. in 1944.

The greatest concentrations during 1949 were found through the late summer and early fall.

Continuation of the tests through 1951 have failed to show the summer peak which was apparent during 1949, and on the whole the general level of 1951 seems to be somewhat lower, though still at a relatively high level.

Noteworthy is the fact that in most determinations made at points remote from Los Angeles city, along the edge of the Mojave Desert and in the lower San Bernardino mountains, test results were approximately at the same level as in the city itself. The exception was during the 1949 summer period, when city results seemed appreciably higher.

The pattern on ozone concentrations, as suggested by these data, is consistent with experience of rubber goods manufacturers in the incidence of weather checking in the southern California area. The possibility of alternate materials or causes for checking other than ozone has been considered. The authors feel that it is unlikely that other factors exert any appreciable effect.

For the Home Lab

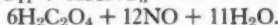
All About Oxalic Acid

by BURTON L. HAWK

Prologue:

Oxalic acid is very widely distributed in nature as the potassium or calcium salt in many plants and vegetables. In sorrel it is found as potassium acid oxalate; in rhubarb as calcium oxalate; in lignite as ferrous oxalate and in guano as ammonium oxalate.

It was first isolated in 1769 by Wiegand. It can be obtained from sawdust by heating with sodium or potassium hydroxide. Or it can be obtained from sugar by oxidation with nitric acid:

$$C_{12}H_{22}O_{11} + 12HNO_3 \rightarrow$$


We feel the latter method is better adapted for the home lab.

Chapter I — The Preparation

Place 5 grams of ordinary cane sugar in a large flask. Add 25 cc. of concentrated nitric acid and heat gently. Soon, as the sugar dissolves, a vigorous reaction takes place accompanied by the evolution of large quantities of brown nitrous fumes. At this point remove the flask from the flame and place in a well-ventilated spot until the action subsides. As the brown fumes are poisonous, it may be best to place the flask outdoors.

When all action has ceased, evaporate the liquid until it is reduced to about 10 cc. Set the dish aside for a day or two, when oxalic acid crystals will form. Or, if you are in a hurry,

evaporate to about 5 cc. and then immerse the dish in ice-water. The oxalic acid will crystallize readily. Dissolve the crystals in the least amount of hot water possible and cool again. Finally, remove the re-crystallized acid and dry carefully by pressing between sheets of blotting paper.

Chapter II — The Confirmation

You can confirm your product by applying several simple tests:

(1) Dissolve a few crystals of oxalic acid in a small quantity of water. Add calcium chloride solution. A white precipitate of calcium oxalate is formed, insoluble in acetic acid, but soluble in dilute hydrochloric acid.

(2) Put a few crystals of oxalic acid in a dry test tube. Add an equal amount of resorcin and about 10 drops of concentrated sulfuric acid. Heat gently. A lovely violet color is obtained.

(3) To a solution of oxalic acid, add a few drops of sulfuric acid. Warm gently and add a dilute solution of potassium permanganate. The latter is de-colored.

Chapter III —

The Decomposition

Heat about one gram of oxalic acid with 3 cc. of concentrated sulfuric acid in a test tube. Carbon monoxide and carbon dioxide are formed. Attach a stopper containing a delivery tube to the test tube. The gas can be

ignited as it flows from the delivery tube. The carbon monoxide will burn with a blue flame. Extinguish the flame and pass the gases through a solution of lime water. The precipitate formed indicates the presence of carbon dioxide.

Chapter IV — The Off-Spring

Silver Oxalate: Neutralize a solution of oxalic acid with ammonium hydroxide. This can most easily be accomplished by adding a drop or two of phenolphthalein solution to 3 or 4 cc. of ammonium hydroxide. Then add a strong oxalic acid solution, stirring, until the pink color *just* disappears. As the color fades, add the last portion of acid drop by drop, being careful not to add too much.

Now add a solution of silver nitrate to the neutral solution, and a snow-white precipitate of silver oxalate is obtained. Filter off the precipitate and dry carefully by applying *gentle* heat. Transfer the powder to a small metal or porcelain dish and heat in a blow-pipe flame. The powder will decompose rapidly with a sudden puffing sound. Carbon dioxide is evolved and silver remains:



Use only a small quantity of powder at a time when heating with the blow-pipe.

Mercuric Oxalate: Dissolve $\frac{1}{2}$ gram ammonium oxalate in 10 cc. of water. Add to this 5 cc. of a saturated solu-

tion of mercuric chloride. Nothing happens. Now set the solution in bright sunlight for a short while. Or, if no sunlight is available, expose the tube to the light of burning magnesium ribbon for about 30 seconds. The colorless solution will turn white. The soluble mercuric oxalate has been reduced to the insoluble mercurous oxalate by the action of light.

Potassium Ferric Oxalate: Here is another example of the reducing action of light. Add a solution of potassium oxalate to a solution of ferric chloride until a clear green liquid is obtained. Add about 1 cc. of potassium ferricyanide solution and expose the tube to bright sunlight (or burning magnesium ribbon). The greenish solution will turn dark blue. Here the ferric ion was reduced by light to the ferrous ion.

Epilogue:

Of course in modern industry, oxalic acid is not obtained by the method outlined above. This is now considered out-moded and old fashioned. It is presently obtained by reacting carbon monoxide with sodium hydroxide at about 350 to 360 degrees C.

Although it is innocent in appearance, oxalic acid is quite poisonous and must be treated with respect.

It is used in the manufacture of ink, dyes, celluloid and metal polishes. It is also used for bleaching straw and leather, cleaning wood, and removing rust and ink stains.

America's first glass factory was at Jamestown, Va.; established in 1608, its principal product was glass beads for use in trading with Indians.

So-called catalytic-cracking is the best known process for converting the heavy, oily portions of petroleum into gasoline.

Industries Cure Stream Pollution

► **STREAM POLLUTION** caused by the pulp and paper industry will be virtually eliminated within the next decade, Harold R. Murdock of Robert and Company Associates, architects and engineers of Atlanta, Ga., predicted to the American Chemical Society.

Speaking before the Society's Division of Water, Sewage and Sanitation Chemistry, Mr. Murdock said that by 1961 modern methods and well-designed equipment will have reduced water contamination by the industry to a matter of little importance.

Older mills must modernize their operations or close down, Mr. Murdock, a chemical engineer, declared. He said that it is the potentially obsolete equipment in these older mills that contributes most to the waste disposal problem of today.

Scarcely any stream pollution is caused by some of the newer plants using improved waste disposal facilities, Mr. Murdock reported, citing a new process for making sulfite pulps devised by one of America's foremost pulp and paper manufacturers. By using new magnesium-based pulping materials, the method promises to be economical in addition to reducing greatly the stream pollution in the area. Older methods of sulfite pulp making, using calcium-based materials, may also be improved by new techniques which reduce stream pollution.

To combat stream pollution, the pulp and paper industry established the National Council for Stream Improvement in 1943. Several regional groups were also organized by local mills to study waste problems in a limited area.

Pollution control commissions in many states now consider the time ripe for action, Mr. Murdock stated. All sections of the industry must heed rising public opinion against industrial pollution by installing equipment which will drastically cut the amount of waste products emptied into streams and rivers. The necessary equipment now exists and can be used to correct pollution in many localities.

Some of the new mills were built with the prime determination to eliminate stream pollution. Abatement of stream pollution was not considered when the older mills in the United States were constructed.

To apply some of the new methods to older mills too abruptly would place a huge financial burden on them, according to Mr. Murdock. He argued against blanket correction orders by the control commissions, contending that the commissions will accomplish more by cooperating with each mill and understanding the local problem.

Oil Refinery Saves Water

► **WASTE WATER** from a petroleum refinery has been decreased by 95 per cent, and equipment is under construction to cut it further to only 3

per cent of its former volume, through a pollution abatement program reported by N. J. Gothard and J. A. Fowler of the Sinclair Refining Company, East Chicago, Ind.

The amount of oil in this refinery effluent has been reduced by half in spite of the fact that the refinery's capacity has been doubled in the meantime, the report said. Other chemical contaminants can be removed at the refinery drains, and much has been accomplished by good housekeeping and the proper instruction of refinery operators.

One of the natural functions of streams and lakes is the drainage of the land, and in its natural state, a stream or lake is capable of receiving a limited amount of pollution in the form of industrial wastes and sanitary sewage without impairing the quality of its water, the report said.

The problems which have arisen with regard to stream and lake pollution have resulted from the concentration of industry and population into relatively small areas without the provision of proper means of treating wastes.

In order to avoid the overloading of a body of water with regard to pollution, cooperation must be obtained from all municipalities as well as from all industries located within the drainage basin of that particular body of water. In order to obtain such cooperation, some kind of court action is usually required. One example of such court action was the law suit *ILLINOIS vs. INDIANA et al—UNITED STATES SUPREME COURT*, filed October 9, 1943. In this suit, a number of industries in the Calumet Region of Indiana were

charged with the pollution of Lake Michigan and ordered to take measures to improve their waste disposal systems.

The Sinclair Refining Company of East Chicago, Indiana, went all out to cooperate in this matter, and developed a Program for Pollution Abatement which changed fundamentally the operation of the existing Refinery as well as the plans for future development of the Refinery. In developing this program, cost was a secondary consideration—the primary consideration was pollution abatement.

The most important feature of the Sinclair Program for Pollution Abatement was the reduction of the volume of the over-all refinery effluent. This was accomplished by installing cooling towers for recycling all cooling and condensing water and by reducing the volume of process water wherever possible. Without these reduction-of-volume measures, the volume of the effluent from the present 90,000-95,000 barrels per day refinery would be more than 100,000 gallons per minute, with these measures, the volume is approximately 5,000 gallons per minute. With these measures, the progress which will further reduce the volume of the effluent to approximately 3,000 gallons per minute.

To remove oil from this reduced refinery effluent, an oil-water separator designed according to the latest edition of the American Petroleum Institute's *Manual on Disposal of Refinery Wastes* was installed. With this A.P.I. separator operating on the present 5,000 gallons per minute effluent, the amount of oil contained in it has been reduced to approximately one-half the

amount that the effluent formerly contained, even though the crude capacity of the Refinery has been increased from 55,000 barrels per day to 90,000-95,000 barrels per day. A further reduction in the oil content of the effluent undoubtedly will occur when the volume is reduced from 5,000 to 3,000 gallons per minute.

Water soluble pollutants such as sulfides and phenol can be removed best at their source before they enter the refinery sewers. Much has been accomplished along this line at East Chicago through good housekeeping measures. In some cases it has been necessary to construct new units for the purpose of eliminating such pollution. In East Chicago, sulfides have been eliminated as a pollution problem and pollution by phenols has been reduced by approximately 90 %.

The reduction-of-volume approach to the pollution abatement problem has resulted in the concentration of pollutants in a comparatively small volume of water; therefore, the tests in parts per million do not indicate a great reduction in pollution; however, when pollution on pounds per day basis is considered, it is evident that the Pollution Abatement Program at the East Chicago Refinery has resulted in a great reduction in the amount of pollution entering Lake Michigan from that Refinery.

Sulfuric Acid Recovery

► A NEW sulfuric acid recovery process for steel mills, oil refineries, and titanium pigment plants, which may help the nation conserve its critically short sulfur supply, was reported to the American Chemical Society.

Manufacturers of fertilizers, paints,

textiles, and explosives are among the major users of sulfuric acid, which is so widely employed in industry that its consumption has been called "the barometer of business," or a "measure of our national prosperity."

The new process, which was reported by F. J. Bartholomew of the Chemical Construction Corporation, New York, is said to recover 85 to 90 per cent of the acid normally discarded in the "pickling operation" of a steel mill, including the acid contained in the iron scale and rust. Pickling is the process by which rust and scale are removed from steel by hot, dilute sulfuric acid.

It was a great shock to industry last fall when the producers of sulfur, from which sulfuric acid is made, announced they could no longer meet full demands, Mr. Bartholomew said. Price increases, reduction in allocations to all consumers with 1951 contracts and reports of black market operations made the sulfur shortage the number one topic for discussion in the chemical industry.

In many of its great variety of industrial uses, sulfuric acid is completely consumed and becomes a part of the manufactured product, as in the production of superphosphate fertilizers and alum, the speaker explained. In other applications it is only partly consumed and a waste product containing unconsumed acid and dissolved impurities must be disposed of or restored to usefulness. In cases of the first kind, little if anything can be done to relieve the present situation. In cases of the second kind, a reduction in allocation of sulfur or sulfuric acid can be more than offset by recovering the acid now going to

waste. Many of the larger consumers of sulfuric acid, such as the oil refiners, steel manufacturers, and the producers of titanium pigment, are in a position of this kind and are making close studies of acid recovery procedures.

The object of the recovery process is to return the sulfuric acid remaining in the used pickle liquor to the pickling operation for re-use, to recover the acid in the iron sulfate of the scale, and to return the rust and scale to the blast furnaces as iron oxide.

The new process involves separation of the iron sulfate by crystallization, after concentrating the liquor by submerged combustion in a special burner in which oil flames blaze beneath the surface of the liquid. The sulfate is filtered out of the liquid on a plastic filter supported by a lead frame. This sulfate is mixed with coal and roasted to produce sulfur dioxide gas, which can easily be converted back into sulfuric acid, and iron oxide, which can be returned to the blast furnace.

"Because of the high investment required and the cost of fuel for water evaporation it is difficult to show a favorable return on a steel mill pickle

liquor recovery plant," the speaker admitted.

"Acid pickling is a very minor item of cost on the steel manufacturer's books and he will probably continue to dump his waste as long as he is able to purchase fresh acid at reasonable cost and is not prevented from dumping it. A shortage of acid and restrictions against dumping it would alter the situation."

The recovery situation is somewhat different as it applies to titanium pigment manufacturers. The by-product from this industry is in such form that recovery is economically feasible. Some objections have been raised by pigment manufacturers, stating that the acid recovered by concentration carries impurities that would contaminate the pigment if the acid were reused. However, there would be a ready market for the recovered acid in other industries and roasted sulfate would produce an acid of a purity suitable for any purpose.

The process described can not be utilized economically in all cases but it is a practical one and can be applied when a scarcity of raw materials or other attending circumstances make it advisable.

Atomic Particles Counted

► AN ATOMIC particle can be counted in a billionth of a second by a new electronic technique developed by Stanford University physicists.

Advantage is taken in the improved device of the fluorescent light that flashes when an atomic particle passes through suitable crystals or liquids.

The scintillation counter made by Dr. Richard F. Post and a team of physicists gets extra speed by operating at 4,000 volts instead of the 1,000 volts used on tube of earlier scintillation counters, which are supersensitive cousins of Geiger counters.

Progress in Peroxides

by DR. HANS O. KAUFFMANN, and FRANK P. GREENSPAN
Buffalo Electro-Chemical Company, Buffalo, N. Y.

A slightly condensed version of a paper presented at the American Institute of Chemists Annual Meeting, 1951. Reprinted from THE CHEMIST, August, 1951.

➤ VERY FEW chemical compounds are known that show such a variety of interesting properties as hydrogen peroxide. This chemical which is generally considered the most important member of the widespread peroxide family has gained great importance in the past decade. Its properties have been thoroughly studied by a great number of investigators, who have thus laid the groundwork for its many applications in science and industry. In fact, hydrogen peroxide is a classical example of how intensive application research can create many new uses based upon a few basic properties.

In this paper we present a number of fields in which peroxides, particularly hydrogen peroxide, have gained in importance and grown in stature, and we show some of the more interesting applications.

By far the largest number of peroxide uses are based on its oxidizing properties.

In terms of quantities of peroxides consumed industry-wise, bleaching has been and still is on top of the list. More items are now bleached with peroxide, particularly hydrogen peroxide, than with any other bleaching

agent, despite the fact that some bleaching agents are considerably cheaper than peroxide.

The main reason for the popularity of peroxides as bleaching agents resides in the following facts:

(a) Peroxides are comparatively mild oxidizing agents and are not harmful to the material to be bleached.

(b) Peroxides do not produce undesirable by-products.

(c) Excess bleaching agent is generally not harmful and if advisable, may be easily removed.

(d) Peroxide bleaching can be easily controlled.

(e) Peroxide bleaching can be modified in many ways so as to make it adaptable to a great many conditions encountered in practice.

It is perhaps a recognition of this last fact that has contributed most to the development of new bleaching processes in recent years. These new processes have greatly simplified existent methods, reduced the overall bleaching cost and opened up a wider use of less expensive raw materials or intermediate products. The progress chart of peroxide bleaching of cotton shows that just before the last war, and especially after the war, the curve took a sharp turn upwards. This was caused by the introduction of continuous bleaching processes. Studies of

the rate of peroxide bleaching revealed that it is possible to bleach cotton in a very short time by applying a small amount of a more concentrated peroxide solution at higher temperatures. Formerly, it took many hours, sometimes days, to produce a satisfactory bleaching effect on cotton. The continuous peroxide process does the process in one to three hours, requires less man hours, less steam and less floor space.

A field in which peroxides have gained great importance since World War II is the pulp and paper industry. Up to then, pulps were used either in the unbleached state for the production of paper and pulp products or were bleached by means of chlorine or hypochlorites. It was found that peroxides are much more effective in bleaching so-called groundwood pulp than any other agents previously investigated. For those who are not acquainted with that particular industry, I would like to point out that groundwood pulp is made by wet grinding of wood. The composition of the groundwood or mechanical pulps is practically identical with that of the wood itself. In contrast to groundwood, chemical pulps are made by digesting wood chips with chemical solutions with an inherent weight loss of 50% or more.

It has been the desire of the pulp and paper industry for a long time to use the low cost groundwood pulp with its inherently valuable properties in higher cost papers. The low brightness of groundwood has been a deterrent for this purpose, but the development of commercially practical peroxide bleaching methods eliminated this disadvantage. Conservation of our

natural resources and reducing of stream pollution gave additional impetus to this development. Cooperative research and development by paper mills and peroxide manufacturers has resulted in the adoption of peroxide bleaching of groundwood. Studies are now made to develop satisfactory and economical peroxide bleaching procedures for chemical pulps. Nowadays many commercial grades of paper contain peroxide bleached pulps, such as those in "Life," "Time," and "Readers Digest," to mention a few magazines, and such items as paper towels, paper napkins, etc.

A great number of diversified materials are now bleached with peroxides, such as oils, fats, waxes, soaps, feathers, hair, leather, marble, lecithin, woollens and furs, to mention only a few. The bleaching of wood surfaces has become quite an art.

Hydrogen peroxide has long been a widely used oxidant for laboratory work in organic synthesis. It is only in recent years, however, that large scale industrial utilization of hydrogen peroxide for organic oxidations has occurred. In part, this is a reflection of several developments.

(1) New and improved reactions utilizing hydrogen peroxide or peracids.

(2) Advances in hydrogen peroxide manufacture leading to the commercial availability of pure and stable highly concentrated grades, e. g. 90% hydrogen peroxide.

(3) The commercial introduction of peracetic acid, a particularly versatile oxidant.

Hydrogen peroxide's low equivalent

weight and its reduction to water in oxidation reactions make it extremely attractive for organic oxidant use. The utilization of hydrogen peroxide, through the medium of a peracid, can most frequently be accomplished by an "in situ" technique wherein hydrogen peroxide is added to an acid solution of the substance to be oxidized. Peracid formation and utilization proceed apace.

It is convenient and practical for our purpose to discuss together hydrogen peroxide and the peracids. Let us examine at this point some of the more noteworthy reactions of hydrogen peroxide and/or peracids.

Peracids react with unsaturated compounds to give oxirane (alpha-epoxy derivatives) and/or glycols.

The product formed is dependent upon the specific structure of the unsaturated material and the conditions under which the reaction is carried out. Since the epoxy ring is sensitive to ring opening, experimental conditions for epoxidation necessitate low temperatures and the absence of strong acids.

The hydroxylation reaction is virtually a quantitative one; the epoxidation reaction only slightly less so. The unsaturated materials may be olefins (aliphatic and alicyclic), unsaturated fatty acids and esters, unsaturated alcohols, fats and oils, terpenes, unsaturated polymers, monomers, etc.

Epoxy compounds are of interest, (1) as reactive intermediates in organic synthesis, (2) as stabilizers for chlorinated polymers, (3) for production of new resins and surface active materials. The oxidation reaction is applicable to production of new long

chain glycols, for the preparation of epoxy acids of interest for synthetic waxes, alkyd resins, lubricating greases, etc.

One of the more recent large scale applications of epoxidation is in the production of a new epoxy insecticide, dieldrin.

The structure minus the epoxy ring is itself an excellent insecticide. The introduction of the epoxy ring in the 6, 7 position is reported to increase the insecticidal potency up to 4-fold, while reducing the vapor pressure to 1/25 of the previous. This results in high residual activity approximately equal to that of DDT.

One of the more glamorous applications of epoxidation is in the production of 17-hydroxysteroids such as cortisone. Introduction of the 17 hydroxy group has proved to be one of the most difficult steps in the synthesis. Julian has described a procedure for the introduction of the 17 hydroxy group proceeding through an epoxidation at the 16-17 double bond of a dihydro starting material.

Typical of quinone formation with hydrogen peroxide or peracids is the oxidation of substituted naphthalenes, such as the synthesis of 2-methyl 1,4-naphthoquinone, related to Vitamin K and of interest for its anti-hemorrhagic, bacterio-static and fungicidal activity.

The oxidation of the ketones provides a novel method of introducing an hydroxy group onto a benzene ring and is much used in steroid work. Using acetophenone as an example, treatment with a peracid results in introduction of an oxygen between the carboxy group and the benzene ring. The resultant acetate is then readily

hydrolyzed into the corresponding hydroxy compound.

One of the more unusual reactions of the peracid is a ring splitting action on benzene rings. Treatment of beta-naphthol with peracetic acid results in scission of one of the rings and formation in excellent yield of o-carboxycinnamic acid. Similarly phenol may be oxidized to the interesting conjugate dibasic acid, muconic acid.

The oxidizing action of hydrogen peroxide also finds many applications in inorganic chemistry. Objectionable metallic impurities in various metal salts are readily removed by precipitation after hydrogen peroxide treatment. Thus, where it is desirable to remove iron from a metallic salt, hydrogen peroxide treatment converts the iron to the ferric state, in which state it can be quantitatively separated as ferric hydroxide. This process finds application in purification of nickel plating solution, in the preparation of beryllium and magnesium from wet processed ores and in phosphatizing of steel, etc.

Percompounds have attracted interest for incorporation into dilute acids used for ore leaching (tungsten, molybdenum) whereby greater and more rapid solubilization of the desired metal is achieved. Addition of hydrogen peroxide to acids can be used to effect solubilization of metals which themselves are insoluble in these specific acids. Thus, metals such as mercury and iron, while insoluble in acetic acid, will dissolve in acetic acid containing hydrogen peroxide.

Although hydrogen peroxide is best known as an oxidizing agent, it functions as a reducing agent in numerous

reactions, for example with permanganate, dichromates, and ceric salts. Recent work of Taube and associates at the University of Chicago indicates that in such reactions all of the oxygen evolved is from the hydrogen peroxide. No transfer of oxygen from solvent or oxidizing agent occurs.

A dilute hydrogen peroxide solution has long been a First Aid standby of the average family. Recently, a solution of hydrogen peroxide in glycerine has attracted considerable attention as a germicide for various infections, particularly of the ear, nose and throat. Hydrogen peroxide dosage of milk was employed on a large scale in Europe during World War II, particularly in Italy.

Recent work has shown peracetic acid to be an excellent bactericide-fungicide. More important, the rate of killing action of peracetic acid against these organisms has been found to be very rapid. Comparative tests against a large number of quaternary ammonium compounds and high chlorine content germicides have shown peracetic acid to be the most effective of some 15 germicides tested against spore forming organisms of the flat sour type. Uniquely, peracetic acid is a temporary germicide, breaking down on application to the surface into innocuous acetic acid and water. It has found application as a germicidal wash for fruits and vegetables and for equipment sanitizing. Dilute peracetic acid solutions sprayed on tomatoes in baskets enable one to maintain virtually static mold counts over prolonged holding and/or transportation periods.

Possibly the most unique property possessed by peroxygen compounds is

their ability to form free radicals. Accordingly, peroxides find wide application in processes initiated by free radicals. These include polymerization reactions of the vinyl type, organic reactions proceeding through a free radical mechanism. Depolymerization reactions may also be considered in this category.

The use of peroxides as polymerization initiators is well known. A wide variety of peroxides have been employed, particularly organic peroxides such as benzoyl peroxide, cumene hydroperoxide. Our war time synthetic rubber program was built on persulfate initiated co-polymerization of butadiene and styrene. Possibly the most notable advance in peroxide catalysis of the last decade has been the development of redox or reduction activated polymerization systems. Various polyvalent metals, e.g. iron and copper, or reducing agents, e.g. sugars and thiosulfate, used in conjunction with peroxygen compounds, have been found to greatly increase the rates of polymerization. Redox polymerization has made possible practical polymerization rates at low temperature. In the synthetic rubber field, this has led to so-called cold rubber possessing superior physical properties.

Many organic reactions of the free radical type can be catalyzed by peroxides. These include addition of polyhalogenated hydrocarbons, e.g. bromoform and the addition of H_2S , NH_3 , HCN to double bonds of an olefin.

Depolymerization reactions are similarly catalyzed by peroxides. Various polymers under the action of heat and a peroxide break down to lower

polymers and monomers. These reactions find use in the recovery of monomers and lower polymers from plastic scrap.

In the presence of peroxides, polymers, such as starch, protein and cellulose, can be made to depolymerize. Treatment of a starch with a dilute solution of a peroxide (persulfate, hydrogen peroxide, peracetic acid) in the presence of a metal catalyst such as copper salt results in a depolymerization and production of a modified starch of lower viscosity and useful properties.

Depolymerization of cellulose can be achieved by treatment of an alkali cellulose with a dilute hydrogen peroxide solution.

Decomposition products of inorganic peroxides are oxygen and water or salts, acids and alkalies. Organic peroxides decompose in various ways; their decomposition products are carbon monoxide, carbon dioxide, oxygen and a variety of organic compounds.

Decomposition of hydrogen peroxide has become of great importance since the last war when the Germans launched their "V" weapons. It played a very important role in the use of chemical propellants for the generation of power. The utilization of the energy produced by the decomposition of hydrogen peroxide was not seriously considered until practical ways and means were found to manufacture and handle concentrated hydrogen peroxide solutions.

The exothermic hydrogen peroxide decomposition reaction as such and the utilization of the formed oxygen for combustion of fuels forms the basis for the use of hydrogen peroxide

as a source of energy. This energy can be released at a comparatively slow rate to create mechanical propulsion or at a very high rate to create explosions.

The following table gives some interesting energy data.

Composition	Temperature °C	
	kg. (adiabatic)	cal./kg. (adiabatic)
100% H ₂ O ₂	690	1000
90% H ₂ O ₂	615	750
11% Octane 89%) H ₂ O ₂ 90%)	1830	2270
H ₂ O ₂ (1) H ₂ O (1) + ½O ₂ (g) + 23 kg. cal.		

In this case, approximately 2/3 of the heat is derived from the combustion of the octane and 1/3 from the decomposition of the hydrogen peroxide.

It is well known that the Germans used hydrogen peroxide as such or in combination with fuels in launching or driving their "V" weapons, torpedoes, airplanes and submarines. In the submarine engine, water was used to reduce the combustion temperature from 4,000° to approximately 1000°F. The hydrogen peroxide catalyst chamber contained permanganate-impregnated porous stones.

Concentrated hydrogen peroxide forms explosive mixtures with a variety of combustible materials. Such mixtures are quite stable when left undisturbed but will detonate violently when subjected to mechanical impact or to a blasting cap. Such explosions may reach detonation velocities close to that of nitroglycerine. Substances which may be detonated in the presence of concentrated hydrogen peroxide are alcohols, aldehydes,

ketones, acids, esters, sugars and many others.

The heat formed from the decomposition of hydrogen peroxide can be utilized in cases where conventional heating methods are impractical or require a primary source of energy which is inaccessible. The rate of heat formation and the temperature desired may be obtained by controlling the rate of decomposition and the concentration of the hydrogen peroxide. It has been proposed for instance, to use such a system in cleaning out oil wells which have become plugged with paraffin.

We have noted that one mole of hydrogen peroxide on decomposition gives rise to one mole of oxygen. Since this reaction can be made to occur at will, and since the only byproduct of the decomposition is water, hydrogen peroxide is a convenient source of oxygen gas. Various techniques have been devised for employing hydrogen peroxide and its salts as a source of pure oxygen, e.g. for breathing apparatus. It is to be noted that oxygen so produced is sterile oxygen generated from a germicidal medium and of interest where sterile air is required.

Soil aeration by addition of hydrogen peroxide to a field has been reported to greatly increase agricultural crop yields.

The development of large volumes of gas from a small volume of hydrogen peroxide (1 volume of 50% hydrogen peroxide gives 197 volumes of oxygen gas) has been utilized in unique procedures for preparation of porous products. Hydrogen peroxide plus a catalyst is incorporated into the product to be formed or made porous. The decomposition of the peroxide

results in an "in situ" blowing of the material. A cross section of the product shows millions of air cells homogeneously dispersed throughout the medium. The density of the product is controlled by the amount of hydrogen peroxide added. Building materials, for example, gypsum, can be formed in this way to give light weight products of superior insulating properties.

Foam plastics and foam rubber can be similarly produced. Several processes employing hydrogen peroxide have been developed to produce foam

rubber. Hydrogen peroxide is added to the formulated latex containing a catalyst. Decomposition of hydrogen peroxide sets in and the latex is foamed in place by the released oxygen. Products ranging in density from that of bus seats to that of very light pillows can be so produced.

In conclusion, progress made in its application has made peroxide an increasingly important factor in our daily lives—perhaps more than you may have realized.

Hint of New Vitamin in Protein

► HINT of a new vitamin or food element essential for rats at least and maybe for other animals, including man, appears in a report from three Italian scientists.

The substance is found in crude casein, which is a protein from milk. It is an animal-protein factor but is not the same as vitamin B 12, state its discoverers, M. Piccioni, A. Rabbi and G. Moruzzi of the University of Bologna Institute of Biochemistry.

The factor is "indispensable for normal growth and reproduction of

rats," they report. It is stored in the animal's body but can be exhausted in two generations. A deficiency of it causes a high mortality, 70% in the first generation and 100% in the second generation. The whole litter always dies and in a very short time.

Newborn rats of the second generation deprived of this factor were saved by small quantities of whole cow's milk, but vitamin B 12, one of the animal protein factors, completely failed to save the animals.

Cotton Strengthened by Cyanide

► COTTON shirts and sheets can be made 10% stronger by a poisonous hydrocyanic acid treatment that Dr. Vernon L. Frampton, University of Texas scientist, found accidentally.

Expected to lengthen greatly the life of cotton garments laundered in soap, the new process arose from experiments attempting to stop bad ef-

fects of mold, bacteria and sunlight on cotton fibers.

Cotton deteriorates when microorganisms or the sun's rays attack the cellulose molecules in a chain, turning them into glucose, Dr. Frampton explained. The hydrocyanic acid adds a carbon atom to each cellulose molecule and strengthens the chain.

Discoveries in Chemical Fields

Copies of complete specifications may be obtained from the Commissioner of Patents, Washington 25, D. C. Order by patent number and enclose 25 cents for each copy. Send money order or Patent Office coupon, but not stamps.

Chemicals Spread Lightning

➤ GREATER safety from lightning is promised with a soil-treatment process, that makes the earth around the ground wire from the lightning rod a better distributor of collected electricity.

The same chemical treatment of the soil is of value also in grounding television antennas, radio transmitters, power lines and transformers. It can be used in the electrolytic protection of pipe lines. The inventor is Ivar Harry Sanick, Stockholm, Sweden. He received American patent 2,558,159.

Clay soils, and others containing considerable humus, are satisfactory conductors to dissipate any electrical charges on the ground wire. But sandy and gravelly soils are not. It is particularly for such soils that the treatment is recommended.

The process consists of injecting into the soil in the vicinity of the buried electrode on the end of the ground wire chemicals that form a type of gel which is a good conductor of electricity. The gels recommended for the purpose are those made from soluble

salts of copper, nickel or cobalt with soluble ferro- and ferri-cyanides.

Sugar Purifier Reusable

➤ THE PROCESS of refining can sugar, in which great quantities of bone char are used for decolorizing, is decreased in cost by methods of regeneration of the char so that it can be used over and over again. An improved process to accomplish this purpose brought patent 2,557,948 to Victor R. Deitz of the National Bureau of Standards, Washington, D.C. The patent is assigned to the government as represented by the Department of Commerce.

This new process greatly decreases the amount of water now used to wash the char to remove inorganic impurities. It consists of treating the char with a solution of an ammonium salt of an organic acid. This replaces inorganic ions adsorbed in the sugar-clarifying process with volatile ions which can be driven off by heat.

Alloys For Electric Joints

➤ COPPER-SILVER alloys suitable for electrical contacts for high electrical conductivity in conjunction with high strength and resistance to wear has brought John Sykes, Enfield, England, an American patent. Tiny amounts of oxygen are used in these alloys.

Copper-silver alloys have been long used for various purposes. This invention, with the special properties mentioned, is obtained by utilizing a silver

content within a given range and including a carefully controlled small percentage of oxygen. It is from 5% to 7% silver, and less than one-tenth of one per cent oxygen.

Patent 2,559,031 was awarded to Mr. Sykes for this invention. Rights have been assigned to Enfield Rolling Mills Limited, also of Enfield, England.

Wax Paper

► WAXED wrapping paper of better quality is promised with a wax composition and method of making it that brought patent 2,559,398 to Robert G. Capell, Pittsburgh, Pa. Rights are assigned to Gulf Research and Development Company of the same city.

The feature of this composition is high tensile strength which prevents it from cracking and breaking when the wrapper on which it is used is roughly handled, crumbled and bent.

This composition contains bentonite, a type of clay found in many parts of the United States. It uses a bentonite-organic base compound with any of the solid or semi-solid waxes. Especially valuable results are obtained when a petroleum wax is used. The resulting product with petroleum wax has not only higher tensile strength but lower penetration and a higher melting point than the original wax.

Oxygen-Containing Fuel

► GAS TURBINE engines in airplanes may become more widely used with a co-called monofuel which contains, in addition to the combustible material, an oxygen-releasing chemical which supplies the necessary oxygen for combustion. Present fuels used in

rockets contain sufficient oxygen to assure combustion.

This newly patented monofuel can be used in rockets, or in other situations where a self-sufficient fuel is desired, but it is recommended particularly for gas turbine engines to permit them to operate without dependence on the atmosphere for oxygen.

The propellant comprises a mixture of approximately 80% to 90% by weight of a methane known to chemists as tetranitromethane as an oxidizing agent, less than 1% of an inhibitor to control the rate of combustion such as tetraethyl lead, and the balance an unsaturated organic liquid fuel such as benzene.

Inventor is John A. Hannum, Detroit, Mich. Patent 2,559,071 was issued to him. Patent rights have been assigned to Borg-Warner Corporation of Chicago.

Metallic Oxides in Ceramics

► IMPROVED ceramics, suitable for ornamental uses and for industrial applications ranging from bearing parts to abrasives, are of the types made with metallic oxides but have varying hardness qualities depending upon the amount of titanium oxide included in them.

These ceramics contain titanium oxide, copper oxide, and two or more of the group composed of oxides of iron, cobalt, nickel and chromium. The characteristics of the composition depend upon the amount of titanium oxide, which may vary up to 65% of the total. Patent 2,560,188 was issued to Daniel Rosenthal, Brooklyn, N.Y., on this invention.

Improved Aviation Gasoline

► **BETTER** fuel of the high-octane type for military and civilian airplanes is claimed in a composition which has brought patent 2,560,898 to Walter A. Schulze and John E. Mahan of Bartlesville, Okla. Phillips Petroleum Company, Bartlesville, has been assigned rights to this improved fuel.

The product is what chemists call an isoparaflinic aviation fuel. This contains a relatively minor proportion of a compound which gives rich-mixture characteristics without undesirably affecting the other characteristics of the fuel. The additive is minor portions of methyl substituted pyridines.

By-Products From Citrus

► **WASTE** citrus liquors, obtained from oranges, lemons and other fruit after the juices for canning have been extracted, yield valuable products under a treatment process which brought patent 2,561,072 to Gustave T. Reich of Philadelphia.

In the preparation of citrus juices for the market, relatively light pressure is used so that the products will not contain an over-supply of oils and other constituents that are undesirable in a juice for beverage purposes. By subjecting the remaining pulp to heavy pressure what is called waste citrus liquor is obtained. By this process this liquor yields products ranging from citric acid to alcohol and yeast.

In it the liquors are partially concentrated, then subjected to alcoholic fermentation. After fermentation has sufficiently progressed, further concentration is carried out during which the alcohol is removed by evaporation.

Then the citric acid is separated from the final concentration, and solid matters dried out as an industrial product.

Better Castings

► **BETTER CASTINGS** of iron are promised by use of an alloying composition on which a patent was granted by the government. The addition of this composition changes the molecular structure of castings to give a finer and more uniform grain.

The inventor is Frank Alden Miller, St. Petersburg, Fla. Patent 2,563,056 was issued to him. Rights are assigned to H. J. Dion Company, a corporation of Michigan. The alloying composition, by weight, is 49 parts tellurium, 40 parts manganese, 10 parts titanium and one rhodium.

The additive is prepared in pellets, and two ounces of it are added to a ton of the molten iron.

Sulfur Recovered

► **PART** of the present shortage of sulfur may be met by a process for the recovery of the essential element from hydrogen sulfide and sulfur dioxide given off in certain industrial processes, particularly in refining petroleum oil and natural gas.

The inventors of this improved process for sulfur recovery are Robert Vose Townend, Arlington, N. J., and Donald Hoyt Kelly, New Hyde Park, N. Y. Allied Chemical and Dye Corporation of New York City has acquired the rights to the patent, 2,563,437.

The process consists in passing the hydrogen sulfide through a solution made by contacting sulfur dioxide with a dilute aqueous solution of aluminum sulfate and sulfuric and sulfurous acid. Elemental sulfur settles out.

Fungal Amylase Replaces Traditional Malt in Converting Starches to Sugar

Mold Produces Grain Alcohol

► ONE OF the nation's most important chemicals, ethyl alcohol, can now be made from cereal grains or other starchy materials by a new process that departs from the traditional use of malt for converting the starches to fermentable sugars. The new process, a U. S. Department of Agriculture development at the Bureau of Agricultural and Industrial Chemistry's Northern Regional Research Laboratory, employs a mold product, fungal amylase, as the converting agent. The use of fungal amylase instead of malt reduces the cost of producing alcohol by an amount that depends upon the difference in price between malt and corn. While these prices fluctuate, malt is invariably higher than corn and the difference in price is usually such that the saving amounts to 3.5 to 4 cents per wine gallon of 190-proof alcohol. One industrial alcohol plant is making extensive tests of the process, which appears suitable for installation and operation in other plants and distilleries throughout the country.

The importance of the Northern Laboratory's achievement stems from the predicament the nation faced in World War II when supplies of malt, made from barley, were so inadequate that rigid allocation became necessary and curtailment of alcohol production from grain appeared imminent. From 1939 to 1945 the country's yearly industrial alcohol requirements had risen from about 100 million to about

580 million wine gallons, an increase of 480%. Although some alcohol was being produced from molasses and by synthesis from ethylene, the bulk was supplied by the fermentation of grains and grain products.

A starch-converting agent for the production of industrial alcohol must be available in ample quantities, cheap, and derivable from noncritical materials. Since certain molds produce amylases that convert starches to sugars just as does barley malt, a search was made throughout the Northern Laboratory's collection of industrially important micro-organisms, one of the largest in the world, for the most efficient producer of fungal amylase. Laboratory scientists eventually uncovered a strain of the mold *Aspergillus niger* that met requirements.

Adaptation of this research to industrial processes required a method for growing the mold in solution, rather than on the semisolid material normally used. In the process finally developed, nutrients for the organism are put into the solution, and air is pumped in to keep the mold growing and, incidentally, to help accomplish the necessary agitation of the solution. Optimum conditions were developed for utilizing the fungal amylase so that the maximum quantity of fermentable sugars may be obtained from the starch contained in the grain.

Tests show that byproduct livestock feeds, such as distillers' grains,

can be recovered from fermentations after the use of fungal amylase. They are similar in appearance and composition to the feed material recovered after the use of malt and have proved fully as nutritious as conventional by-product feeds.

Although the fungal amylase process was not developed completely until after hostilities ended in World War II, it would be a ready asset in national defense, should the Nation again be faced with extreme demands

for industrial alcohol production. Foremost among the peacetime possibilities of the process is its important bearing on the production of alcohol for motor fuel, one of the more promising outlets for surplus grains.

R. W. Jackson, Head, Fermentation Division; and C. T. Langford, Head, Engineering and Development Division, Northern Regional Research Laboratory, Bureau of Agricultural and Industrial Chemistry, lead the research group.

Sense of Smell Still Mystery

► SCIENCE is not yet sure how you smell a rose, a broiling beefsteak, a favorite perfume or any other odor.

Tests reported in California call in question the heat absorption theory of sense of smell put forth in 1947 by Drs. Walter R. Miles and Lloyd H. Beck, Yale University psychologists.

The Miles-Beck theory says that the substance producing the odor gives off a gas that absorbs infrared or heat radiation of certain wavelengths given off within the nose. This loss of heat detected in the nose's olfactory sense organ is signaled to the brain and interpreted as the sensation of odor. They did their original work on bees. Earlier theory held that odor is a chemical sense, aromatic particles hitting the nose and going into solution on its moist inside lining.

So-called "cutless bearings" are rubber-faced bearings, used to support ship propeller shafts and for other underwater installations; they are metal sleeves lined with a special rubber compound.

Menthol is an alcohol usually obtained from oil of peppermint or other mint oils; following wartime restrictions on importations from Japan and China, it can now be made synthetically.

Now Drs. A. Theodore Forrester and Wm. E. Perkins of the physics department at University of Southern California have set up tests that they feel do not support the infrared theory. Odor-containing air kept at constant temperature of the body and breathed by a person still produced the sensation of odor, whereas the experimenters suggest that under the Miles-Beck theory this should not be the case.

Such tests, as reported in the journal *Science*, are not considered conclusive, and they suggest a further test of the theory by inserting into the nasal passages a sealed tube of odorous gas in a container transparent to the heat rays that are supposed to be absorbed to produce the odor effect.

New Lubricants and Polishes From Silicon-Oxygen-Carbon

Slippery Customers

Reprinted from INDUSTRIAL BULLETIN of Arthur D. Little, Inc.

► SILICONE resins, since they were introduced in 1943, have found enough unsuspected uses to build up a business of several million dollars a year. These unique resins, chemically a cross between glass and ordinary plastics, are especially notable for their resistance to extreme temperatures. They are also incompatible with many other materials, and this property has made them especially useful as mold-release agents and in a number of small-volume applications.

Based on a framework of silicon and oxygen, modified by carbon-containing organic groups, the silicones are available as liquids, semi-solids, grease-like compounds, rubbery solids, and resins that solidify permanently under heat to form flexible heat-resistant films. The largest market, according to industry reports, is as mold-release lubricants. Silicone fluids have become the standard mold-release agents in the rubber industry, and are used to prevent sticking of the molded rubber product to the forming mold, thus resulting in improved products and higher production. Silicone fluids and compounds are also widely used in plastics molding and in the "shell" process for making foundry molds and cores for cast iron and other metals. Because of the advantages of this process and the size of the foundry business, this use may become one of the biggest markets for silicones. Related

to the mold-release application is the use of a silicone resin as glaze for bakers' pans, good for 150 or so bakings, which eliminates greasing and washing the pans.

Another market for silicones is car and furniture polishes. The silicone composition spreads easily, reducing or eliminating polishing, and the finish is claimed to resist dirt and weather. Since the silicone finish is more incompatible with paints than are waxes, touching up the paint job on a fender or scratch, for example, requires special preparation of the whole surface to be painted.

With a silicone varnish, fibrous glass, and mica insulating the windings, an electric motor can be run hotter, and hence a given size can put out more work than with earlier types of insulation. Silicone varnishes have found application in some large electric motors subject to high overload or exposed to high temperatures, excessive moisture, or corrosive atmospheres, or in transportation motors where space is valuable.

So far, the cost of the resins, an average of about \$3.50 a pound, has prohibited use in the most common types of industrial motors. Although no dramatic reduction is in sight, silicone prices have come down steadily, and with most other prices going up, their position is improving. Unfortunately, the huge household-appliance

market for motors is limited as an outlet for silicones by the lack of satisfactory silicone enamel flexible enough to coat the wires for winding small motors.

Silicone rubbers, because of their remarkable resistance to oil and extremes of temperature, are widely used as gaskets, seals, mechanical parts and insulating materials for field coils and cable exposed to temperatures far above and below the limits of organic rubbers. Major markets at present are in the aircraft and automotive industries and in communication and ignition cable. Silicone oils are used in viscous vibration dampers that eliminate torsional vibration of engine crankshafts. Heavy Diesel engines and several models of automobiles are so equipped. These fluids are also used to damp ammeters, gas gauges, and speedometers. They are used in some aircraft hydraulic systems to insure operation of landing gears and wing flaps at extremely low temperatures.

Parking meters are also frequently lubricated with silicone oils.

One of the miscellaneous uses of silicones is in the suppression of foaming occurring in the manufacture of paints, paper, soap, and other products. Silicone paints to withstand high temperatures, up to 600° F., are on the market, but need for special high-temperature equipment to dry them limits their use. A new silicone finish for stoves and other consumer products, soon to be introduced, is said to be harder than the usual organic finish, but more flexible and more stain- and mar-resistant than the enamels used on household appliances.

Familiar to consumers are the silicone-impregnated tissues for wiping eyeglasses, and the bouncing putty, whose only uses at present seem to be as a leveller for furniture resting on uneven floors, as centers for golf balls, and as a source of amusement for children and adults.

Dye in Veins Measures Flow of Blood

► A NEW medical technique, developed from an old-fashioned engineering process, may become a tool for studying congenital heart defects.

Dr. A. E. Lewis, Dr. Raymond D. Goodman and Dr. M. L. Pearce of the University of California's Atomic Energy Project have adapted the engineering process to research which measures the amount of blood flowing away from the hearts of rabbits.

Actually, the method is not new, said Dr. Lewis, but modern electronic equipment made it possible to "rediscover" this technique of blood flow measurement. Here is how it works:

Engineers have long known how to

measure the rate of water flow through pipe lines by adding a dye to the water and then measuring the concentration of the dye at the point of outlet. The faster the flow, the more diluted the dye.

The U.C.L.A. scientists injected a blue dye into the veins of rabbits, and, with the aid of a new type of photoelectric cell, known as a "photomultiplier," were able to measure the amount of dye in the arteries of the rabbits' ears.

Although the experiments were conducted on rabbits, it may be possible some day to adapt such research to studies of congenital heart defects in human beings.

Book Concentrates

- *Basic Theories of Physics: Heat and Quanta*—Peter G. Bergmann (Prentice-Hall, 300 p., \$6.70.) For graduate students.
- *The Chemical Technology of Dyeing and Printing, Vol. II: Substantive, Basic, Acid, and Pigment Colors, Aniline Black, and Dyestuffs for Acetate Rayon and Synthetic Fibers*—Louis Diserens (Reinhold, 446 p., \$12.00.) Translated and revised from the second German edition.
- *Collection and Burning of Locomotive Cinders*—E. J. Boer, J. M. Allen, and B. A. Landry (Bituminous Coal Research, Inc., 8 p., paper, 20 cents.) Results of the continuing tests of the Norfolk and Western Railway Co. and Bituminous Coal Research, Inc.
- *Natural Rubber and You*—(Natural Rubber Bureau, 28 p., illus., paper.) Free upon request to publisher, 1631 K Street, N. W., Washington, D. C. Interesting facts and statistics on this material, vital in both peace and war.
- *Colloquium on Plastic Flow and Deformation Within the Earth*—B. Gutenberg, Chairman (National Research Council, 155 p., illus., paper, \$2.00.) Volume 32 Number 4 of the Transactions of the American Geophysical Union including papers read at a meeting in Sept. 1950.
- *Maternal Nutrition and Child Health: An Interpretive Review*—Kirsten Utheim Toverud, Genevieve Stears and Icie G. Macy (National Research Council, 174 p., paper, \$2.00.) Intended to help save the many lives of babies now lost during their first year.
- *Major Activities in the Atomic Energy Programs, January-June 1951*—U. S. Atomic Energy Commission (Govt. Printing Office, 151 p., paper, 35 cents.) A reprint of the AEC 10th semiannual report.
- *Elementary School Science and How to Teach It*—Glenn O. Blough and Albert J. Huggett (Dryden Press, 532 p., illus., \$5.25.) The teacher who has to be a "jack-of-all-trades" in the scientific courses will welcome this handy teaching guide.
- *New and Nonofficial Remedies*—Council on Pharmacy and Chemistry, American Medical Association (Lippincott, 782 p., \$3.00.) An annual handbook for the reference of physicians.
- *Nobel: The Man and His Prizes*—H. Schuck and others (University of Oklahoma Press, 620 p., illus., \$6.00.) A short biographical note followed by a description of the work which has won the Nobel awards over the years.
- *Sanitary Milk and Ice Cream Legislation in the United States: A study of Laws and Ordinances Establishing Sanitary Standards for Milk, Cream and Ice Cream*—A. C. Dahlberg and H. S. Adams (National Research Council, 59 p., paper.) Free upon request to publisher, 2101 Constitution Ave., Washington, D. C.
- *Theory of Perfectly Plastic Solids*—William Prager and Philip G. Hodge (Wiley, 264 p., illus., \$5.50.) A textbook for seniors and graduates containing material most of which is very new.

Proudly Presented

- **TEACHING AIDS** Catalogue revised for 1951-52, prepared by Westinghouse and listing audio-visual material, charts, posters and booklets useful for junior and senior high school teachers of science, social studies, agriculture, home economics, industrial arts and photography, is available for teachers. Write to the School Service Department, Westinghouse Electric Corp., P. O. Box 1017, Pittsburgh 30, Pa. and ask for Catalogue B-5408.
- **VARIABLES** in groundwood bleaching have been studied by F. R. Sheldon of the Research and Development Department, Buffalo Electro-Chemical Co. The results of his statistical evaluation of these factors are available in Bulletin 31 from the Becco Sales Corp., Station B, Buffalo 7, N. Y.
- **A GAS ANALYSIS** Manual is now in its fourth revised edition explaining the Fisher Scientific Company's unitized gas analysis apparatus. The Manual, by Maryan P. Matuszak, is published by the Fisher Scientific Co. and is available from its centers at Pittsburgh, New York, Washington, St. Louis and Montreal.
- **THE ATOMIC ENERGY** Commission issues from time to time lists of patents it holds which are available for public use. Licenses are obtained through the Chief of the Patent Branch, Office of the General Counsel, U. S. Atomic Energy Commission, Washington 25, D. C.
- **CONTRACTS** with the Atomic Energy Commission have been signed by Bendix Aviation Corp., Detroit, Mich. and Tracerlab, Inc., Boston, Mass. to study the commercial feasibility of manufacturing, processing and selling radioisotopes.
- **CARBON BLACKS** for rubber are described in a circular and carbon blacks for inks, paint, plastics and similar purposes are classified in a full-color chart issued by Godfrey L. Cabot, Inc., 77 Franklin St., Boston 10, Mass. The company offers to co-operate in exploring effective applications for types of carbon to meet particular needs.
- **ALATHON** polythene resin for insulation of undersea cables and TV transmission lines is featured in the October-November issue of the Dupont Magazine, Wilmington, Del.
- **ION EXCHANGE** is the research subject to which the Eli Lilly Co. devotes its Research Today, Vol. VII, No. 3. It is published at Indianapolis 6, Ind.
- **AIRCRAFT** Engine Oils are featured in the October issue of Lubrication, published by the Texas Co., Texaco Petroleum Products, 135 E. 42nd St., New York 17, N. Y.
- **THE SARGENT** mercury cathode vessel is the scientific method described in "Scientific Apparatus and Methods" fall edition, issued by E. H. Sargent and Co., 4647 W. Foster Ave., Chicago 30, Ill.
- **PROGRESS** and Prospects of research in physiology, nutrition and special uses of sugar are summarized in the seventh annual report of the Sugar Research Foundation, Inc., 52 Wall St., New York 5, N. Y.

You Can Help Their Understanding
with **CHEMISTRY**

for Christmas



IF TWO or more subscriptions are ordered at one time (your own renewal subscription can be one of them), the cost is \$4.00 for the first and \$3 for each additional subscription. A single subscription is \$4.00. Gift subscriptions will begin with the September issue, with the four fall issues being mailed at once with a specially designed Christmas card announcing your gift.

SEND
CHEMISTRY To
as a Gift

Street

City &
State

SEND
CHEMISTRY To
as a Gift

Street

City &
State

and check here ☐ if you wish us also to extend your
own subscription upon expiration as part of this Christmas order

Signed

Street

City &
State

